

GL  
401  
C742  
INVZ

# bollettino malacologico

international journal of malacology

XLVIII 2012

supplemento 9

ARIE W. JANSSEN

Late Quaternary to Recent holoplanktonic Mollusca (Gastropoda)  
from bottom samples of the eastern Mediterranean Sea:  
systematics, morphology



Autorizzazione del Tribunale di Milano  
n. 479 del 15 ottobre 1983  
Poste Italiane - spedizione in a.p. - 70%  
Direzione Commerciale - Napoli  
maggio 2012 spedizione n. 1/2012



SOCIETÀ ITALIANA DI MALACOLOGIA

Casella Postale n. 436 I-80133 NAPOLI Succ. 83 - e-mail: paolo.crovato@fastwebnet.it - tommasi@postanet.it - sito web: http://www.sim-online.it  
Sede Sociale: c/o Museo di Scienze Planetarie, via Galgianese 20H, 59100 Prato

CONSIGLIO DIRETTIVO 2007-2010

Presidente: Bruno Dell'Angelo    Vicepresidente: Paolo Crovato    Segretario: Maurizio Forli    Tesoriere: Franco Agamennone  
Consiglieri: Enzo Campani, Alessandro Ceregato, Sergio Duraccio, Nicola Maio, Giuseppe Martucci, Ermanno Quaggiotto, Walter Renda, Paolo Russo, Ignazio Sparacio, Francesco Toscano  
Revisori dei Conti: Antonio Di Nisio, Pasquale Micali

REDAZIONE SCIENTIFICA - EDITORIAL BOARD

Direttore - Editor in Chief: Rafael La Perna  
Co-Editore - Co-Editor: Giuseppe Manganelli, Dipartimento di Scienze Ambientali, Università di Siena  
Co-Editore - Co-Editor: Francesco Mastrototaro, Dipartimento di Biologia Animale, Università di Bari  
Co-Editore - Co-Editor: Paola Monegatti, Dipartimento di Scienze della Terra, Università di Parma  
Co-Editore - Co-Editor: Francesco Paolo Patti, Laboratorio di Ecologia Funzionale ed Evolutiva, Stazione Zoologica Dohrn, Napoli  
Co-Editore - Co-Editor: Marco Taviani, ISMAR, Sezione di Bologna CNR

Abbreviazione - Abbreviation: Boll. Malacol.

CITATO NEI: Zoological Record, A.S.F.A. (Aquatic Sciences and Fisheries Abstracts) e Thomson Scientific Publications (Biosis Previews, Biological Abstracts).

ISTRUZIONI PER GLI AUTORI

LINEA EDITORIALE

Il Bollettino Malacologico è pubblicato dalla Società Italiana di Malacologia. Sono accettati manoscritti su tutti gli aspetti della malacologia, che siano scritti in una delle seguenti lingue: Italiano, Inglese, Francese e Spagnolo. L'uso dell'Inglese è vivamente raccomandato. Vengono pubblicati tre numeri per anno. La pubblicazione di monografie ed articoli più lunghi di trenta pagine andrebbe preventivamente accordata con l'Editore. I manoscritti sottoposti per la pubblicazione si intendono essere inediti, non sottoposti contemporaneamente ad altre riviste, ed approvati da tutti gli eventuali co-autori. La presentazione dei manoscritti avviene esclusivamente per via elettronica, all'indirizzo del Direttore Scientifico (rafael.laperna@uniba.it), come files .doc o .rtf. Le illustrazioni possono essere fornite come files .pdf o .jpg di buona qualità. Gli Autori sono tenuti ad applicare le seguenti istruzioni e le regole del Codice Internazionale di Nomenclatura Zoologica, pena il rifiuto del manoscritto da parte dell'Editore. I manoscritti sono soggetti a peer-review da parte di almeno due referee. Gli Autori possono suggerire dei referee potenziali, ma la scelta resta ad insindacabile giudizio dell'Editore.

ORGANIZZAZIONE DEL MANOSCRITTO

La prima pagina del manoscritto riporta il titolo, il nome e l'indirizzo dell'autore/i, completo di indirizzo elettronico. In caso di lavoro svolto da più autori è necessario indicare l'autore corrispondente, con cui l'Editore manterrà i contatti. Il titolo deve essere informativo, ma il più possibile breve, scritto in minuscolo, grassetto. Vanno evitate abbreviazioni. I nomi di rango sistematico elevato vanno riportati tra parentesi. La seconda pagina contiene un riassunto nella stessa lingua del testo principale. Per i manoscritti in lingua diversa dall'Inglese, occorre un abstract più esteso del riassunto. I riassunti devono riportate, in sintesi, i principali risultati del lavoro e le conclusioni, non semplicemente gli scopi o frasi generiche. I caratteri distintivi dei nuovi taxa possono essere brevemente riportati, ma non descrizioni o diagnosi estese. Si evitino riferimenti bibliografici. Dopo i riassunti, va riportato un elenco di parole chiave (non più di sei), nella stessa lingua del testo principale. Il testo principale del manoscritto va organizzato in parti distinte, tipicamente le seguenti: Introduzione, Materiale e metodi, Risultati, Discussione, Conclusioni, Ringraziamenti, Bibliografia, in minuscolo, grassetto. In lavori di tipo tassonomico, la parte relativa alla sistematica va intitolata Sistematica (in genere sostituisce Risultati). Titoli di secondo ordine, quali Descrizione, Materiale esaminato, Osservazioni, ecc. sono scritti in testo normale, minuscolo. Si evitino le note a pie' di pagina. Gli Autori sono tenuti ad adottare uno stile chiaro e conciso, evitando frasi eccessivamente lunghe. È vietato l'uso di termini offensivi o discriminatori. Tutte le abbreviazioni e gli acronimi usati nel testo devono essere spiegati, possibilmente in Materiale e metodi. Si usino le abbreviazioni formalizzate per le unità di misura (es.: "m", non "mt." per metro) e gli acronimi ufficiali per le istituzioni. Solo i nomi di generi, sottogeneri, specie e sottospecie vanno scritti in corsivo, non quelli dei taxa di rango più elevato. Alla loro prima citazione, i nomi delle specie e quelli dei generi devono comprendere il nome dell'autore e l'anno di pubblicazione. È possibile abbreviare i nomi dei generi, facendo attenzione a che non si crei confusione con generi diversi citati nel testo con la stessa iniziale. Il corsivo va usato anche per riportare citazioni nella lingua originale (tra virgolette), se diversa da quella del manoscritto. I nuovi taxa devono essere citati per la prima volta quando vengono descritti, ad eccezione del riassunto. Il Latino può essere usato per indicare i livelli tassonomici (es.: Familia o Famiglia). Le diagnosi (facoltative) e le descrizioni vanno redatte in stile telegrafico, quando possibile. L'elenco dei sinonimi dovrebbe comprendere solo i riferimenti principali, utili a garantire l'identità della specie trattata (per es.: quelli relativi a materiale esaminato dall'Autore o riferimenti ben documentati in letteratura).

Esempio di gerarchia sistematica e sinonimia:  
Family Cardiidae Lamarck, 1809  
Subfamily Cardiinae Lamarck, 1809

Genus Acanthocardia Gray, 1853  
(type species Cardium aculeatum Linné, 1758)

Cardium indicum Lamarck, 1819  
(Fig. 1A-D, Fig. 2C)

Cardium hians Brocchi, 1814: p. 508, tav. 13, fig. 6 (non Spengler, 1799).  
Cardium indicum Lamarck, 1819: p. 4.  
Cardium (Cardium) indicum Lamarck - Fischer-Piette, 1977: p. 112, tav. 10, fig. 4 (tipo).

CITAZIONI E RIFERIMENTI BIBLIOGRAFICI

Tutte le pubblicazioni alle quali si fa riferimento nel testo, incluse le sinonimie (ma non gli autori di omonimi), devono comparire nell'elenco bibliografico finale, in ordine alfabetico. Titoli di riviste e di libri in alfabeti diversi da quello Latino vanno traslitterati, mentre i titoli vanno tradotti in Inglese, aggiungendo una nota che indichi la lingua originale, come per esempio "[in Russo]". È importante eseguire un attento controllo incrociato fra citazioni bibliografiche nel testo ed elenco bibliografico, prima di sottoporre il manoscritto.

Esempi di citazioni:  
... riportato da Richardson & Smith (1965)  
... come noto in letteratura (Ross et al., 1993; Rosenberg, 1995, 1997; Michelini & Andriani, 2000)  
... l'illustrazione originale (Torwald, 1879: p. 56, tav. 2, fig. 5).

Esempi di bibliografia:  
SALAS C., 1996. Marine Bivalves from off the Southern Iberian Peninsula collected by the Balgim and Fauna 1 expeditions. *Haliotis*, **25**: 33-100.  
GRILL B. & ZUSCHIN M., 2001. Modern shallow- to deep-water bivalve death assemblages in the Red Sea - ecology and biogeography. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **168**: 75-96.  
BOSS K.J., 1982. Mollusca, in Parker S.P. (ed.), *Synopsis and Classification of Living Organisms*. Vol. 1. McGraw-Hill, New York: 945-1166.  
CARTER J.G., CAMPBELL D.C. & CAMPBELL M.R. 2000. Cladistic perspectives on early bivalve evolution, in Harper E.M., Taylor J.D. & Crame J.A. (eds), *The Evolutionary Biology of the Bivalvia*. *Geological Society, London, Special Publications*, **177**: 47-95.  
VOKES H.E., 1980. *Genera of the Bivalvia: a systematic and bibliographic catalogue (revised and update)*. Paleontological Research Institution, Ithaca, Edwards Brothers Inc., 307 pp.

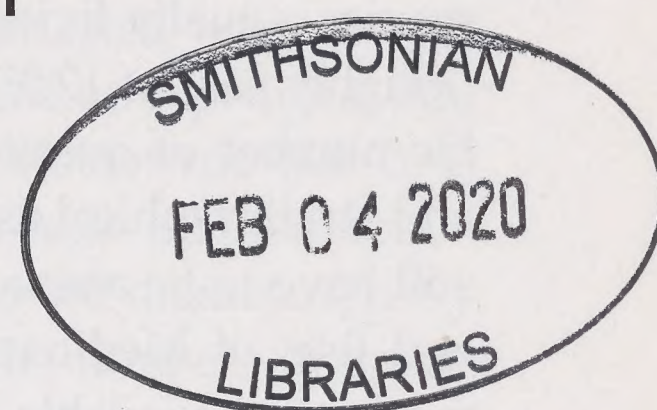
ILLUSTRAZIONI

Le illustrazioni devono essere di alta qualità, in formato elettronico (.tiff), con una risoluzione non più bassa di 400 dpi per le fotografie e di 600 dpi per i disegni ed i grafici. Vanno preparate alle esatte dimensioni di stampa, in formato colonna singola (8,4 cm) o colonna doppia (17,2 cm). L'area di stampa massima è 17,2 x 26,5 cm. La dimensione delle illustrazioni va scelta con attenzione e buon senso, sulla base della complessità e quantità delle immagini contenute, al fine di ovviare a risultati scientificamente poco utili ed esteticamente poveri, oltre allo spreco di spazio di stampa. Tutte le illustrazioni sono numerate progressivamente, in un'unica serie, con numeri arabi, nello stesso ordine in cui sono citate nel testo. Nelle illustrazioni composite, le singole immagini vanno indicate con lettere maiuscole, di altezza pari a 3-5 mm, usando un carattere sans-serif, quale Helvetica od Arial. Indicazioni ed abbreviazioni sulle illustrazioni vanno in minuscolo. Le illustrazioni vanno citate nel testo come figure, usando le abbreviazioni Fig. e Figg., come nell'esempio: Fig. 3, Fig. 6A-F, Fig. 5A, 7B, Figg. 3, 5. Le illustrazioni in altri lavori vanno citati come fig. o figg. Le immagini, montate su fondo nero o bianco, devono avere dimensioni adeguate ad un'agevole lettura, non più piccole di 4-5 cm, né eccessivamente grandi. Devono essere



# Late Quaternary to Recent holoplanktonic Mollusca (Gastropoda) from bottom samples of the eastern Mediterranean Sea: systematics, morphology

Arie W. Janssen\*



\* Netherlands Centre for Biodiversity Naturalis, P.O. Box 9517, NL-2300 RA Leiden, The Netherlands; currently: 12, Triq tal'Hamrija, Xewkija XWK 9033, Gozo, Malta; ajanssen@go.net.mt

## Abstract

Holoplanktonic molluscs of 62 bottom samples and the sieving residues < 0.6 mm of a single gravity core, were evaluated. The total number of species found in all samples together is 49 (Pterotracheoidea 11, Janthinidae 2, Limacinoidea 5, Cavolinioidea 16, Cymbulioidea 8, Gymnosomata 5, *incertae sedis* 2). Results obtained from the residues of bottom samples only give information about which species have been present in the roughly estimated interval 'late Pleistocene to Holocene, Recent included'. The gravity core samples were previously dated on the basis of planktonic Foraminifera, comprising the interval of latest Saalian (Marine Isotope Stage 6) to Holocene, and some more detailed information on the vertical distribution of the species could be obtained. Construction of a 'palaeoclimatological curve', as done by numerous earlier authors, was not attempted. In the systematic part a neotype is designated for *Atlanta keraudrenii* Lesueur, 1817, and a lectotype for *Steira lamanoni* Eschscholtz, 1825, making both taxa to junior synonyms of *Atlanta peronii* Lesueur, 1817. *Clio pyramidata* f. *tyrrhenica* nov. f. is introduced. For many species morphological details and questions concerning systematics and/or nomenclature are discussed, in various cases also related to the desired position of a taxon at species, subspecies, or infraspecific level.

## Key words

Holoplanktonic Mollusca, Pterotracheoidea, Janthinidae, Thecosomata, Gymnosomata, systematics, Mediterranean, late Quaternary.

## Riassunto

[Molluschi oloplanctonici tardo-quaternari ed attuali (Gastropoda) da campioni di fondo del Mediterraneo orientale: sistematica, morfologia]. Sono stati presi in esame i molluschi oloplanctonici (Heteropoda, Janthinidae, Thecosomata e Gymnosomata) provenienti da 62 campioni di fondo raccolti da spedizioni Meteor e conservati in gran parte presso lo Senckenberg Museum (Francoforte sul Meno, Germania), e da diverse campagne dell'Istituto di Scienze Marine (ISMAR, Bologna). Tutti i campioni provengono dalla parte orientale del Mediterraneo (Tirreno, Ionio e Bacino di Levante). Inoltre, sono stati esaminati i residui < 0.6 mm di un carotaggio a gravità, ubicato ad est di Gávdhos. In totale, sono state trovate 49 specie (Pterotracheoidea 11, Janthinidae 2, Limacinoidea 5, Cavolinioidea 16, Cymbulioidea 8, Gymnosomata 5, *incertae sedis* 2). I campioni ottenuti per dragaggio di solito forniscono semplicemente informazioni sulle specie presenti in un intervallo grossolanamente stimato come Pleistocene superiore-Olocene, incluso l'Attuale. I campioni del carotaggio erano stati in precedenza datati tramite i foraminiferi planctonici, che indicano l'intervallo compreso tra il Saaliano terminale (*Marine Isotope Stage* 6) e l'Olocene. Per questi campioni è stato possibile ottenere dettagli sulla distribuzione verticale delle specie, sulla base di oltre 25.000 esemplari, in prevalenza giovanili o larvali. L'unico campione di età saaliana, appena sotto il sapropel S5, assieme ai campioni dell'intervallo Eemiano comprendenti i sapropels S5, S4 ed S3, hanno fornito le associazioni oloplanctoniche più ricche, con oltre 2.000 esemplari per cm di sedimento in alcuni casi, e fino a 27 specie differenti per campione, alcuni delle quali sono indicatori di acque calde. Durante il Weichseliano, il numero di esemplari per specie diminuisce drasticamente e le specie di acque calde sono quasi del tutto assenti, mentre una ben nota "specie fredda", *Limacina retroversa*, è presente nei due terzi superiori dell'intervallo. Nella parte olocenica, comprendente gli ultimi 23 cm della carota, il numero di esemplari e di specie per campione torna ad aumentare, ma senza raggiungere i valori registrati per l'Eemiano, e ricompare la "specie calda" *Heliconoides inflata*. Nella parte sistematica, molta attenzione è dedicata alla morfologia e/o alla microstruttura di esemplari particolarmente giovani o larvali. In molti casi la tassonomia, la sinonimia e/o la nomenclatura delle specie viene discussa, con conseguenti insolite denominazioni, come per esempio il nome *Atlanta selvagensis* per *A. inflata*, *Creseis clava* (Rang, 1828) per *C. acicula* (Rang, 1828) (entrambi già discussi in precedenti lavori), e *Oxygyrus inflatus* Benson, 1835, per ciò che è di solito indicato come *O. keraudrenii* (Lesueur, 1817). I nomi *Peracle elata* (Seguenza, 1875) e *P. diversa* (Monterosato, 1875) sono accettati per le specie di solito indicate come *P. triacantha* (Fischer, 1882) e *P. apicifulva* (Meisenheimer, 1906), rispettivamente. Particolare attenzione è dedicata alle conchiglie larvali di specie praticamente noto solo attraverso le loro forme adulte, prive di conchiglia: *Pterotrachea*, *Firoloida*, *Cymbulia*, e diverse specie di Gymnosomata. Un tipo finora sconosciuto di conchiglia larvale di Pseudothecosomata (indicato come *Peracle?* sp.), riscontrato in numero considerevole nei campioni della carota e in diversi campioni di Bologna, rappresenta forse la conchiglia larva finora sconosciuta di *Desmopterus papilio*. In alcuni casi, non si concorda con l'elevazione di taxa a rango specifico, come avvenuto nella letteratura recente nell'ambito dei generi *Diacria* o *Cavolinia*, e si è dell'opinione che in futuro saranno necessarie analisi di DNA per risolvere problematiche di questo tipo in maniera più oggettiva. Viene designato un neotipo per *Atlanta keraudrenii* Lesueur, 1817, ed un lectotipo per *Steira lamanoni* Eschscholtz, 1825, entrambi sinonimi di *Atlanta peronii* Lesueur, 1817. Viene descritta *Clio pyramidata* f. *tyrrhenica* nov. f.

## Parole chiave

Mollusca oloplanctonici, Pterotracheoidea, Janthinidae, Thecosomata, Gymnosomata, sistematica, Mediterraneo, tardo Quaternario.



## Introduction

In spite of a large number of publications on Mediterranean holoplanktonic molluscs an up-to-date list of species actually living in the eastern part of that basin (roughly east of 12°E) is not available and a considerable number of questions on systematics, nomenclature and stratigraphical as well as geographical distribution still have to be answered. In the last few decennia several lists of Mediterranean mollusc species appeared, partly also available on the internet (e.g. Sabelli et al., 1990-1992; Bedulli et al., 1995; Giovine in Stoch, 2003; Ramazzotti et al., 2006, 2007) etc., but such lists usually are concentrated from the existing literature and are not based on primary research.

Richter (1968) recorded 12 heteropod species from the Gulf of Naples, five of these being species without a shell in the adult stage (for three of them also the larval shell was described). Rampal (1975) arrived at a total number of 29 Mediterranean pteropods. Piani (1980), in a list of shell bearing, living Mollusca covering the entire Mediterranean basin listed only seven Heteropoda and 27 Pteropoda. Corselli & Grecchi (1990), however, discussing Mediterranean Thecosomata, accepted only 13 species as continually living (and reproducing) in the basin, among a total of 32 recorded species. Sabelli et al. (1990-1992) mentioned 11 Heteropoda and 30 Pteropoda (all Thecosomata). Bedulli et al. (1995) listed 29 Thecosomata and 17 Gymnosomata. Ramazzotti et al. (2007) listed (with synonyms, but without discussion, and including species only known as fossils) 11 Heteropoda, 4 Janthinidae and 30 Thecosomata, but no Gymnosomata.

A large number of papers, apart from observations on the living stock, also cover (usually late Pleistocene and/or Holocene) fossil assemblages, obtained from Mediterranean bottom samples and cores, and frequently used for palaeoclimatological interpretations: Vérany, 1853 (recording living fauna from near Nice, France); Carus, 1890 (who predominantly concentrated records from still older literature), Oberwimmer, 1898; Steuer, 1911 (Adriatic, pteropods observed alive, mainly listed after earlier literature); van Straaten, 1966 (analyzing cores of late Pleistocene-Holocene age from the SE Adriatic); Bottema & van Straaten, 1966; Froget, 1967; Chen, 1968; Blanc-Vernet et al., 1969; Vergnaud Grazzini & Rosenberg Herman, 1969; Pastouret, 1970; Colantoni et al., 1970; Di Geronimo, 1970; Herman, 1971a (with most data repeated in 1971b), 1973, 1981; Herman & Rosenberg, 1971; Froget & Pastouret, 1972; Nordsieck, 1973; Vatova, 1974; Buccheri, 1979; Rampal, 1975, 1979; Morlotti & Torelli, 1979, 1980; Buccheri & Torelli, 1981; Torelli & Buccheri, 1981, 1983; Buccheri, 1983, 1984, 1985; Buccheri & di Stefano, 1984; Grecchi & Bertolotti, 1988; Vergneau-Grazzini et al., 1988; Biekart, 1989; Violanti et al., 1991; Buccheri & Bertoldo, 1992; Buccheri et al., 1994; Rampal, 1996a.

Many of these authors applied the numerical presence of the 'cold water' species *Limacina retroversa*, compared to that of 'warm water' species, such as *Heliconoides in-*

*flata*, *Limacina trochiformis*, *Cavolinia inflexa*, *Diacria trispinosa* etc., to reconstruct Quaternary palaeoclimatological curves. Palaeotemperatures were also estimated using protoconch volumes of the species *Clio pyramidata* Linné, 1767 (van der Spoel, 1975, Diester-Haass & van der Spoel, 1978; Biekart, 1989).

In the present paper no new data are presented on the living fauna, as all material studied originates from more or less superficial bottom samples and from one longer, so-called 'gravity core', all originating from E of Sardinia. This paper aims at an inventory of late Quaternary-Holocene shell-bearing pelagic molluscs and discusses systematical and morphological items.

## Abbreviations

DCS	David P. Cilia, Santa Venera, Malta (private collection).
MNHN	Muséum national d'Histoire naturelle, Paris, France.
MZB	Museo di Zoologia (now Museum of Evolution), Bologna, Italy.
NHMUK	The Natural History Museum, London, UK (formerly BMNH).
RGM	Netherlands Centre for Biodiversity Naturalis, Palaeontology Department (formerly Rijksmuseum van Geologie en Mineralogie), Leiden, The Netherlands.
RMNH	Netherlands Centre for Biodiversity Naturalis, Malacology Department (formerly Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands.
SMF	Senckenberg Museum, Malacology Department, Frankfurt am Main, Germany.
Ku	beam-trawl (German: 'Baumkurre').
Kg	box core (German: 'Kastengreifer').
H	shell height.
W	shell width.
H/W	height/width ratio (= $H/W \times 100$ ).

Names and authors of species are given (inclusive of abbreviations and/or spelling errors) as they occur in the cited paper, if necessary completed (between square brackets) by the present author. Annotations preceding the synonyms are those of Richter (1948) and Matthews (1973):

- \* – first valid introduction of a taxon;
- – responsibility for the identification is accepted by the present author;
- (no symbol) responsibility for the identification is not accepted by the present author, but there is no reason for doubt;
- ? – in the opinion of the present author there is reason to doubt the identification;
- v – the original material of this reference was studied by the present author;
- ( ) – (date between brackets) the year of publication is uncertain (or the paper has not been published officially, e.g. thesis).



and additionally:

*non* – erroneous identification, in the opinion of the present author.

## Material and methods

### *Meteor box core (Kg) and beam trawl (Ku) samples*

Picked holoplanktonic mollusc material from 36 box core and beam trawl samples, all collected during the Meteor 25 (1993) expedition in the eastern Mediterranean were made available by Dr Ronald Janssen (SMF). For a list of samples see **Tab. 1**, the locations are indicated in **Fig. 1**. The Meteor samples, as usual, were washed aboard ship on a 0.5 mm mesh, which means that the smallest specimens (pterotracheids, gymnosomes *etc.*), as well as most juveniles and larval shells, unfortunately are lost. Incidentally, a few of these could be retrieved from sediment remaining in larger pteropods, such as *Clio* or *Cavolinia*. Washing residues were picked out for collection purposes by the mollusc department of the Senckenberg Museum, during which the holoplanktonic species were kept apart from the benthics. This procedure means that only more or less complete and/or well-preserved specimens are present, giving just a qualitative impression of the assemblages. Most of the Ku samples obviously are incomplete, as only some of the larger species are represented. The

composite samples were sorted to species level by the present author, the identified material is housed in the Senckenberg Museum (SMF registration numbers), apart from some duplicate specimens, housed in collection RGM. Two further, as yet unsorted box core 0.5 mm sieving residues, one from the same expedition (Me 25-37 Kg 1) and one from a 1987 Meteor trip (Me 5/1, sample 19 Ku) were donated to RGM in their entirety. Sample Me 5/1, 19 Ku was only sorted qualitatively by the present author, as uncountable numbers of specimens, especially so in the finer fractions, were present. This sample still contained a restricted quantity of residue under 0.5 mm, yielding some specimens of the smallest species.

Most specimens from the various box core/beam trawl samples are in excellent condition, varying from crystal clear to opaque, partly of course because they were selected for collection purpose only. In several samples, however, specimens are decalcified to a certain degree and in a few samples part of the specimens is represented by internal, presumably calcitic moulds.

Additionally, material from sample Meteor 51/3 St. 562 (Hemleben, 2002) was studied from the collection of David P. Cilia (Santa Venera, Malta).

### *Gravity core*

Gravity core T87/2/20G was collected on May 14, 1987, W of Gávdhos, at coordinates 34°58'4"N 23°44'8"E and



**Fig. 1.** Eastern Mediterranean Sea with location of gravity core T87/2/20G (1987), Meteor 25 (1993) sample numbers (11-13, 15-25 and 37-39), samples Meteor 5/1-19 (1987) and Meteor 51/3-562 (2001), Bannock (1974, Tyrrhenian) samples T74-55 and T74-65 and sample G19-2 (MEDITS2007), SW of Malta. Rectangle (solid line) = approximate location of Corsaro samples (2006, Ionian Sea), rectangle (broken line) = approximate location of Bannock samples (1972-1974, Ionian Sea).

**Fig. 1.** Mar Mediterraneo orientale con l'ubicazione del carotaggio a gravità T87/2/20G (1987), i campioni (11-13, 15-25 e 37-39) Meteor 25 (1993), i campioni Meteor 5/1-19 (1987) e Meteor 51/3-562 (2001), i campioni Bannock (1974, Mar Tirreno) T74-55 e T74-65 ed il campione G19-2 (MEDITS2007), a sud-ovest di Malta. Rettangolo (linea continua) = ubicazione approssimativa dei campioni Corsaro (2006, Mar Ionio), rettangolo (linea punteggiata) = ubicazione approssimativa dei campioni Bannock (1972-1974, Mar Ionio).



Sample	Area	Coordinates	Water Depth	Leg.	Coll.
Me5/1-19 Ku	South of Crete	34°43.00'N 25°51.60'E to 34°41.60'N 25°49.90'E	1626-1433 m	F.S. "Meteor" 5/1, 1701. 1987	RGM
Me25-11 Kg1	Golfo di Tarento	40°01.68'N 17°16.41'E	1529 m	F.S. "Meteor" 18.05.1993	SMF
Me25-12 Kg2	Golfo di Tarento	39°53.78'N 17°41.52'E	504 m	F.S. "Meteor" 18.05.1993	SMF
Me25-13 Kg1	Ionian Sea	39°24.84'N 18°56.78'E	911 m	F.S. "Meteor" 19.05.1993	SMF
Me25-13 Kg2	Ionian Sea	39°24.79'N 18°56.87'E	912 m	F.S. "Meteor" 19.05.1993	SMF
Me25-13 Ku	Ionian Sea	39°25.53'N 18°53.55'E	851-862 m	F.S. "Meteor" 19.05.1993	SMF
Me25-15 Kg1	Ionian Sea	37°38.89'N 18°24.67'E	3008 m	F.S. "Meteor" 20.05.1993	SMF
Me25-15 Kg2	Ionian Sea	37°38.83'N 18°24.86'E	3004 m	F.S. "Meteor" 21.05.1993	SMF
Me25-15 Ku	Ionian Sea	37°37.89'N 18°23.69'E	2996-3018 m	F.S. "Meteor" 20.05.1993	SMF
Me25-16 Kg1	off Sapienza	36°36.48'N 21°34.28'E	3848 m	F.S. "Meteor" 22.05.1993	SMF
Me25-16 Kg2	off Sapienza	36°36.38'N 21°34.02'E	3848 m	F.S. "Meteor" 23.05.1993	SMF
Me25-16 Ku	off Sapienza	36°35.69'N 21°31.50'E	3832-3947 m	F.S. "Meteor" 22.05.1993	SMF
Me25-17 Kg1	S of Pelopónnisos	35°50.52'N 22°19.91'E	4764 m	F.S. "Meteor" 23.05.1993	SMF
Me25-17 Kg2	S of Pelopónnisos	35°50.55'N 22°20.04'E	4766 m	F.S. "Meteor" 23.05.1993	SMF
Me25-18 Kg1	SE of Crete	34°44.42'N 25°51.55'E	1431 m	F.S. "Meteor" 25.05.1993	SMF
Me25-18 Kg2	SE of Crete	34°44.39'N 25°51.09'E	1383 m	F.S. "Meteor" 26.05.1993	SMF
Me25-19 Kg1	SE of Crete	34°25.04'N 26°05.75'E	4391 m	F.S. "Meteor" 27.05.1993	SMF
Me25-19 Kg2	SE of Crete	34°24.91'N 26°05.74'E	4391 m	F.S. "Meteor" 27.05.1993	SMF
Me25-20 Kg1	Levantine Basin	34°02.59'N 27°46.73'E	2472 m	F.S. "Meteor" 27.05.1993	SMF
Me25-20 Kg2	Levantine Basin	34°02.74'N 27°46.73'E	2455 m	F.S. "Meteor" 28.05.1993	SMF
Me25-20 Ku	Levantine Basin	34°03.23'N 27°44.89'E	2454-2461 m	F.S. "Meteor" 28.05.1993	SMF
Me25-21 Kg1	Levantine Basin	33°36.29'N 28°34.21'E	3037 m	F.S. "Meteor" 29.05.1993	SMF
Me25-21 Kg2	Levantine Basin	33°36.18'N 28°34.25'E	3039 m	F.S. "Meteor" 29.05.1993	SMF

**Tab. 1.** Box core and beam trawl samples taken by Meteor 5/1 (1987), Meteor 25 (1993) and Meteor 51 (2001) cruises in the eastern Mediterranean. Kg = box core, Ku = beam trawl.

**Tab. 1.** Campioni da *box corer* e da dragaggio raccolti dalle campagne oceanografiche Meteor 5/1 (1987), Meteor 25 (1993) e Meteor 51 (2001) nel Mediterraneo orientale. Kg = *box core*, Ku = dragaggio.



Me25-22 Kg2	Levantine Basin	33°14.77'N 29°27.43'E	2948 m	F.S. "Meteor" 30.05.1993	SMF
Me25-22 Ku	Levantine Basin	33°15.30'N 29°27.07'E	2878-2885 m	F.S. "Meteor" 30.05.1993	SMF
Me25-23 Kg1	Levantine Basin	32°40.97'N 30°35.61'E	1945 m	F.S. "Meteor" 31.05.1993	SMF
Me25-23 Kg2	Levantine Basin	32°40.91'N 30°35.81'E	1944 m	F.S. "Meteor" 31.05.1993	SMF
Me25-23 Ku	Levantine Basin	32°42.22'N 30°31.90'E	1993-2025 m	F.S. "Meteor" 31.05.1993	SMF
Me25-24 Kg1	off Egypt	32°19.50'N 31°10.53'E	1007 m	F.S. "Meteor" 31.05.1993	SMF
Me25-24 Kg2	off Egypt	32°19.42'N 31°10.60'E	1006 m	F.S. "Meteor" 31.05.1993	SMF
Me25-25 Kg1	off Nile delta	32°00.57'N 31°53.24'E	199.2 m	F.S. "Meteor" 01.06.1993	SMF
Me25-25 Ku	off Nile delta	32°00.54'N 31°53.70'E	196-199 m	F.S. "Meteor" 01.06.1993	SMF
Me25-37 Kg1	S of Cyprus	33°19.98'N 33°24.75'E	1875 m	F.S. "Meteor" 03.06.1993	RGM
Me25-37 Ku	S of Cyprus	33°25.02'N 33°26.47'E	1889-1942 m	F.S. "Meteor" 03.06.1993	SMF
Me25-38 Kg1	S of Cyprus	34°25.82'N 32°37.06'E	2474 m	F.S. "Meteor" 04.06.1993	SMF
Me25-38 Ku	S of Cyprus	34°27.44'N 32°27.82'E	2427-2437 m	F.S. "Meteor" 04.06.1993	SMF
Me25-39 Kg1	S of Cyprus	34°01.85'N 32°04.22'E	2600 m	F.S. "Meteor" 05.06.1993	SMF
Me25-39 Kg2	S of Cyprus	34°01.91'N 32°04.38'E	2603 m	F.S. "Meteor" 05.06.1993	SMF
Me51-3 St. 562	off Libyan coast	32°46.45'N+ 19°11.46'E	1390 m	F.S. "Meteor" 17.11.2001	DCS

(cont'd) **Tab. 1.** Box core and beam trawl samples taken by Meteor 5/1 (1987), Meteor 25 (1993) and Meteor 51 (2001) cruises in the eastern Mediterranean. Kg = box core, Ku = beam trawl.

(segue) **Tab. 1.** Campioni da *box corer* e da dragaggio raccolti dalle campagne oceanografiche Meteor 5/1 (1987), Meteor 25 (1993) e Meteor 51 (2001) nel Mediterraneo orientale. Kg = *box core*, Ku = dragaggio.

a water depth of 707 m by the Tyro 1987/2 Crete Perimeter Cruise, a Dutch/Greek research project in the eastern Mediterranean. The recovered core has a length of 2.835 m and was originally split up into three sections, numbered 1-3 from bottom to top, with lengths of 1 m, 1 m and 0.835 m, respectively. These sections were studied for planktonic Foraminifera, as a contribution to the PhD of E.J. Rohling of the Geological Institute of Utrecht University (The Netherlands) by two students of the same institute, viz. R.H.G. van Rijckevorsel (section 3) and G.J. Weltje (sections 1-2). Results were not published, but are recorded in internal reports (van Rijckevorsel, 1988; Weltje, 1988). Mollusca were analysed from the remaining sieving residues of 150-600 µm, which therefore yielded exclusively juvenile specimens/ protoconchs. All mollusc specimens are in the RGM-collections.

*Bologna samples (ISMAR-CNR)*

As in most of the Meteor samples the finer sieving residues were absent I asked Dr Marco Taviani (Institute of Marine Sciences-CNR, Bologna, Italy) for additional, preferably unwashed eastern Mediterranean bottom samples. This request was generously rewarded by making a large number of samples available for study from the Ionian Sea as well as some samples from the Tyrrhenian hosted in the repository of ISMAR-CNR, Bologna. Many such bottom samples were collected by the former Laboratorio de Geologia Marina of CNR (now ISMAR-CNR), in the early 1970's during RV 'Bannock' cruises CJ72, J73 and J74- (Ionian Sea) and T74- (Tyrrhenian Sea) (see Sartori, 1977). Another number of samples was recovered in 2006 during the CORSARO cruise of RV. 'Urania' (CR-samples, Ionian Sea.).



Unwashed samples were processed by the present author on a 0.125 mm mesh. A selected number of these samples was subsequently analysed for this study. Benthic molluscs and a selection of the non-molluscs from these samples are returned to Bologna, washed residues of many other samples, as well as the picked residues still containing all micro-fossils (foraminifers, ostracods *etc.*), are made available to Professor Patrick J. Schembri (Malta University). Details of the analysed samples are given below and in **Tab. 2**.

Many of the Bologna samples are collected by 'draga' (= dredge). It was custom in those days to dredge using heavily chained iron geologic dredges to seek for 'rocks'. Many times they intercepted soft sediments of various ages, often clogging to the dredge: an iron cylinder hitting the seafloor and being dragged for some time. Once on deck of the ship the content of the dredge is extruded and one tries to reconstruct 'stratigraphy'. One 'geometric' stratigraphy is the position of sediment from the dredge entrance ('bocca' = mouth) to the gridded end ('fondo' = bottom), which of course gives no clue on the real stratigraphic position of subsamples (data from M. Taviani, *in litt.*).

The age of the specimens, dredged from bottom sediments to a depth of up to 0.50 m below sea floor (but usually less) varies most probably from late Pleistocene to Recent. Although obviously depending upon local situations, the Holocene muddy drape of the Mediterranean Sea bottom at bathyal depths is normally rather thin, in the order of few cm (*e.g.* only 23 cm in gravity core T87/2/20G). In principle, bottom sediment in box-cores might therefore be older than Holocene. Only precise dating (C14, biostratigraphy) could solve this problem but was beyond the scope of this paper.

#### *Corsaro-cruise (2006), Ionian Sea*

CR 20 Off Gallipoli, 39°55'09" N 17°36'42" E to 39°55'08" N 17°36'42" E, 612.45-612.92 m water depth, April 29, 2006, 135 g (grab).

CR 31 Off Gallipoli, 39°50'06" N 17°37'42" E to 39°50'03" N 17°37'42.2" E, 1090 m water depth, April 29, 2006, 40 g (grab). Fine, very slightly clayey sand, residue 14 g.

CR 33 Off Gallipoli, 39°49'58" N 17°36'50" E to 39°49'59.4" N 17°36'49.2" E, 1276 m water depth, April 29, 2006, 110 g (grab). Apparently a washed sample, finer fractions are almost for 100% foraminifera (mainly globigerinids), but also yielding quite numerous pteropods. Specimens of *Heliconoides inflata* and some other species frequently look very fresh. Few specimens are in internal mould preservation. The fraction < 0.2 mm contains much mica. Identified specimens are in MZB.

CR 34 Off Santa Maria di Leuca, 39°33'20" N 18°13'15" E to 39°33'18" N 18°13'15" E, 540.8-547 m wa-

ter depth, April 30, 2006 (grab). Grey fine sand, 95 g, sieving residue 12 g, containing abundant plant debris (?). Most pteropod and heteropod specimens are quite fresh, only few specimens are in internal mould preservation.

CR 39 Off Santa Maria di Leuca, 39°33'14.8" N 17°36'50" E to 39°33'27.4" N 18°13'16.3" to 18°13'11.1" E, 577-540 m water depth, April 20, 2006, epibenthic grab. Light brownish, fine-sandy sample of 90 g, washing residue 48 g, containing numerous small pteropods and heteropods. Only few specimens are in internal mould preservation. Surprisingly many specimens of *Atlanta lesueurii* are present. Among the non-mollusca many fragments of crustaceans (decapods). Of a second sample from this locality (40 g, residue 34 g, all < 2 mm) only the fractions > 0.5 mm were analyzed.

CR 42 Santa Maria di Leuca, 39°29'58" N 18°14'31" E to 39°30'39.6" N 18°14'11.3" E, 755-802 m water depth, April 20, 2006, epibenthic dredge, 285 g.

CR 68 Santa Maria di Leuca, 39°28'18.6" N 18°21'57.8" E to 39°29'10" N 18°22'13" E, 790-776 m, May 2, 2006, epibenthic dredge. Sample consisting of fine foraminifera sand, 125 g, residue of 98 g, containing no fraction > 2 mm. Abundant small heteropods and pteropods are present. Fractions < 0.3 mm are analyzed only pro parte because of overwhelming quantities of foraminifera.

CR 70 Santa Maria di Leuca, 39°28'29" N 18°22'01" E to 39°28'26.56" N 18°21'59.10" E, 780-778.7 m water depth, 2 May 2006, grab, 85 g, residue of 15 g, yielding almost exclusively juvenile specimens, among which the rare *Pterotrachea* sp. 1.

#### *Bannock-cruises (1972-1974), Ionian Sea*

Sample CJ72 III-20, 38°55.2' N 17°21.6' E to 38°55.6" N 17°20.8' E, 1297-1181 m water depth, August 1972, dredge. Grey clay, 100 g. Small residue yielding almost exclusively juvenile pteropod specimens.

Sample CJ72 III-21, 39°02.1' N 18°03.1' E to 39°02.0" N 18°02.0' E, 2346-2177 m water depth, August 1972, dredge. Yellowish-grey, sandy clay, 110 g. The residue yielded relatively few species. A further sample from the same locality, but marked 'bottom', of 205 g, yielded a residue, all < 2 mm, of only 4 g. Many, mainly juvenile holoplanktonic specimens are present, but in a rather fragile state of preservation (slightly decalcified).



Station	Gear	Area	Date	Coordinates	Sea-Depth		
BANNOCK 1972-1974							
CJ72 III-20	dredge	Ionian Sea	6-29/8/1972	38°55.2'N 17°21.6'E	to	38°55.6''N 17°20.8'E	1297-1181 m
CJ72 III-21	dredge	Ionian Sea	6-29/8/1972	39°02.1'N 18°03.1'E	to	39°02.0''N 18°02.0'E	2346-2177 m
CJ72 III-22	dredge	Ionian Sea	6-29/8/1972	39°00.5'N 18°02.0'E	to	39°01.0''N 18°00.5'E	2499-2401 m
CJ72 III-23	dredge	Ionian Sea	6-29/8/1972	39°14.8'N 17°36.2'E	to	39°145.3''N 17°35.8'E	1084-917 m
CJ72 III-25	dredge	Ionian Sea	6-29/8/1972	39°32.7'N 18°05.0'E	to	39°33.1''N 18°04.9'E	950-904 m
CJ72 III-27	dredge	Ionian Sea	6-29/8/1972	38°48.0'N 18°38.4'E	to	38°48.5''N 18°39.9'E	2350-1707 m
J73-6	dredge	Ionian Sea	6-25/5/1973	38°11.3'N 17°40.2'E	to	38°12.6'N 17°39.2'E	2278-1940 m
J73-17	dredge	Ionian Sea	6-25/5/1973	38°18.7'N 17°46.0'E	to	38°19.3'N 17°44.7'E	2589-2059 m
J73-29	dredge	Ionian Sea	6-25/5/1973	39°09.8'N 17°40.1'E	to	39°09.7'N 17°38.6'E	1731-1351 m
J74-9	dredge	Ionian Sea	12-26/8/1974	39°03.3'N 18°54.2'E	to	39°00.9'N 18°53.1'E	1148-1148 m
J74-10	dredge	Ionian Sea	12-26/8/1974	39°03.6'N 18°54.2'E	to	39°03.5'N 18°54.0'E	1196-1126 m
J74-12	dredge	Ionian Sea	12-26/8/1974	39°33.3'N 18°04.7'E	to	39°33.6'N 18°05.5'E	1017-1060 m
J74-19	dredge	Ionian Sea	12-26/8/1974	39°23.4'N 17°53.0'E			2291 m
BANNOCK 1974							
T74-55	dredge	Tyrrhenian	4-22/6/1974	39°35.3'N 13°51.0'E			3103-2165 m
T74-65	dredge	Tyrrhenian	4-22/6/1974	38°52.8'N 14°09.8'E	to	38°50.0' N 14°09.8' E	3120-2510 m
CORSARO 2006							
CR20	Grab	off Gallipoli	29/4/2006	39°55'09''N 17°36'42''E	to	39°55'08''N 17°36'42''E	612.45-612.92 m
CR31	Grab	off Gallipoli	29/4/2006	39°50'06''N 17°37'42''E	to	39°50'03''N 17°37'42.2''E	1090-1090 m
CR33	Grab	off Gallipoli	29/4/2006	39°49'58''N 17°36'50''E	to	39°49'59.4''N 17°36'49.2''E	1276-1276 m
CR34	Grab	S. M. di Leuca	29/4/2006	39°33'20''N 18°13'15''E	to	39°33'18''N 18°13'15''E	540.8-547 m
CR39	Ep. dredge	S. M. di Leuca	30/4/2006	39°33'14.8''N 18°13'16.3''E	to	39°33'27.4''N 18°13'111''E	577-540 m
CR42	Ep. dredge	S. M. di Leuca	30/4/2006	39°29'58''N 18°14'31''E	to	39°30'39.6''N 18°14'11.3''E	802-755 m
CR68	Ep. dredge	S. M. di Leuca	2/5/2006	39°28'18.6''N 18°21'57.8''E	to	39°29'10''N 18°22'13''E	790-776 m
CR70	Grab	S. M. di Leuca	2/5/2006	39°28'29''N 18°22'01''E	to	39°28'26.56''N 18°21'59.10''E	780-778.7 m

**Tab. 2.** Bologna samples analyzed for the present paper, Bannock (1972-1974, Ionian Sea), Bannock (1974, Tyrrhenian Sea) and Corsaro (2006, Ionian Sea) cruises.

**Tab. 2.** Campioni d Bologna studiati nel presente lavoro, campagne oceanografiche Bannock (1972-1974, Mar Ionio), Bannock (1974, Mar Tirreno) e Corsaro (2006, Mar Ionio).



Sample CJ72 III-22 (bottom), 39°00.5' N 18°02.0' E to 39°01.0' N 18°00.5' E, 2499-2401 m water depth, August 1972. Grey clay, c. 100 g, residue only 7 g with relatively few, small and poorly preserved (decalcified) specimens, and mica flakes. Identified specimens are in MZB.

Sample CJ72 III-23, 39°14.8' N 17°36.2' E to 39°145.3' N 17°35.8' E, 1084-917 m water depth, August 1972. Small, incomplete sample with only some larger specimens.

Sample CJ72 III-25 (top), 39°32.7' N 18°05.0' E to 39°33.1' N 18°04.9' E, 950-904 m water depth, August 1972 (dredge). Yellowish-grey clay, 170 g, residue contains several blackish phosphorites with epibionts and some pieces of white calcareous rock. Part of the pteropod material is in internal mould preservation.

Sample CJ72 III-27 (centre), 38°48.0' N 18°38.4' E to 38°48.5' N 18°39.9' E, 2350-1707 m water depth, August 1972 (dredge). Hard grey clay, 180 g, residue 7 g, containing small rock fragments and in the finer fractions many planktonic foraminifera. Coarser fractions yielding few molluscs only, among which *Limacina retroversa* and *Diacria trispinosa* (as fragments), but from the residue < 0.5 mm numerous small species and juveniles of larger ones were collected (e.g. over a hundred specimens of *Gymnosomata*).

Sample J73-6, 38°11.3' N 17°40.2' E to 38°12.6' N 17°39.2' E, 2278-1940 m water depth, May 1973, dredge. Gray clay, sediment sample of 140 g. Residue consisting of practically 100% foraminifera (globigerinids) in the fractions < 0.5 mm. Only two species of holoplanktonic molluscs, mainly *Limacina retroversa*, with traces of aragonite dissolution, but no internal moulds.

Sample J73-17, 38°18.7' N 17°46.0' E to 38°19.3' N 17°44.7' E, 2589-2059 m water depth, May 1973, dredge. Yellowish clay, 125 g, sieving residue 48 g, containing some larger, brownish phosphorites and yellowish-grey rock fragments, both with epibionts and the latter containing specimens of *Limacina retroversa*. The sample contains abundant isolated specimens of *Limacina retroversa*. Two internal moulds are present of *Cavolinia tridentata* and several of *Clio pyramidata* f. *lanceolata*. Among the non-molluscs many bony fish otoliths are present. Sieving fractions under 0.5 mm consist for 99.9% of foraminifera and were not analyzed.

Sample J73-29, 39°09.8' N 17°40.1' E to 39°09.7' N 17°38.6' E, 1731-1351 m water depth, May 1973,

dredge. An already washed residue of c. 10 g only.

Sample J74-9, 39°03.3' N 18°54.2' E to 39°00.9' N 18°53.1' E, 1148 m water depth, August 1974, dredge. Washed (?) sample of predominantly coarse specimens, with only a very small quantity of the fraction < 1 mm. Furthermore, a sediment sample (brownish-grey clay, 130 g) the washed residue of which includes only very restricted numbers of globigerinids and therefore was very rewarding for the smaller holoplanktonic mollusc species. Specimens are partly in shell preservation, partly as internal moulds. Materials from the two samples are combined in the collection. To save time abundant larger species were only collected from the coarser fractions, their more juvenile specimens occur, sometimes in thousands of specimens, in the finer residues.

Two further sediment samples from this station consist of 165 and 105 g of yellowish-grey to yellowish-brown clay, their residues of 15 g and 11 g respectively contain consolidated limestone flakes and large quantities of foraminifera. These samples were not analyzed.

Sample J74-10, 39°03.6' N 18°54.2' E to 39°03.5' N 18°54.0' E, 1196-1126 m water depth, August 1974. Sample (< 5 g) of yellowish-grey clay, residue with relatively many, but very small molluscs, partly in internal mould preservation, and only few foraminifera.

Sample J74-12, 39°33.3' N 18°04.7' E to 39°33.6' N 18°05.5' E, 1017-1060 m water depth, August 1974. Two samples: a washed residue containing many blackish phosphorites (95 g) and some fossil material, mainly internal moulds of molluscs, and a sediment sample (195 g) of yellowish-grey clay, the residue of which (~ 40 g) contains only few of these phosphorites and exists for a very large part of foraminifera. Only parts of the fraction < 0.3 mm were inspected. A small part of the pteropods is in internal mould preservation.

Sample J74-19, 39°23.4' N 17°53.0' E, 2291 m water depth, 12-26 August 1974. A single sample from a core of 480 cm length. Gray clay, position in the core not indicated, but obviously from a relatively cold period: very common *Clio pyramidata* f. *tyrrhenica* and *Limacina retroversa*, furthermore one specimen of *Firoloida desmarestia* and *Clio polita* only.

Bannock-cruise (1974), Tyrrhenian Sea

Sample T74-55, subsample 6, 39°35.3' N 13°51.0' E, dredged at 3103-2165 m water depth, June 1974.



Block of yellowish clay, 700 g and a bag of partly washed sediment, without the fraction < 1 mm, 105 g.). Washing this sample in hot water hardly resulted in a reduction, only the block of sediment disintegrated in smaller pieces (0.5-1 cm size) of slightly lithified clay or very soft limestone, during which some adult specimens of *Diacria trispinosa* and *Clio pyramidata* became visible. After drying the sample was treated with hydrogen peroxide 3%, resulting in almost complete disintegration of the matrix, but still containing a considerable portion of sediment in the fractions < 1 mm. Floating material freed during the various washings was caught and contains, apart from 99% or more foraminifers also some molluscs, among which numerous *Limacina retroversa*. Even a second treatment with peroxide did not result in a clean residue (final weight < 1 mm 220 g). The two residues are united, the floating residue is kept separate. The 220 g residue was not analyzed, as it is too strongly diluted to be useful.

Sample T74-65, subsamples 1, 2, 9 and 10, 38°52.8' N 14°09.8' E to 38°50.0' N 14°09.8' E. dredged at 3.120-2.510 m water depth, June 1974.

#### Subsample T74-65-1.

Yellowish clay pieces, 300 g. Washing in hot water followed by H<sub>2</sub>O<sub>2</sub> treatment resulted in a clean > 0.125 mm residue of only 10 g, containing abundant foraminifers and small heteropods/pteropods, the larger ones all fragmented. Fractions < 0.3 mm contain relatively few foraminifera and are therefore very rewarding for mini-molluscs: numerous gymnosomatous larval shells could be collected. *Limacina retroversa* is completely absent in this sample.

#### Subsample T74-65-2.

A sieving residue of mainly foraminifera and pteropods and still containing some sediment; 43 g. Sample washed again on 0.125 mm mesh (dry residue then 24 g). Only smaller, mainly juvenile specimens present, assemblage including many *Limacina retroversa*. Fraction < 0.3 mm picked only pro parte.

#### Subsample T74-65-9.

Yellowish clay pieces, 630 g. Processing this sample with hot water was not successful. Treatment with H<sub>2</sub>O<sub>2</sub> reduced the material with c. 50%, the residue containing a few larger limestone pieces and still slightly lithified clay pieces. Second washing with peroxide also was not very successful: residue still containing matrix pieces (weight 175 g). Floating

fraction consists of planktonic foraminiferids and a few molluscs (*Limacina retroversa* and as a surprise a nice specimen of *Peracle moluccensis*, the only one in this study). Fractions > 0.5 mm contain many multicolor minerals (volcanoclastics?), fractions < 0.5 mm consist for practically 100% of foraminifera and volcanic ashes. Not analyzed as there are hardly any molluscs in it, except for very few juvenile *Limacina retroversa*. The floating residue is kept separate.

#### Subsample T74-65-10.

A washed sample of yellowish-grey limestone pieces, with *Clio* and *Cavolinia* present; 120 g. This sample, apparently washed on a 0.25 mm mesh, is characterized by the presence of abundant small limestone pieces, in which occasionally specimens of the pteropod *Limacina retroversa* and some specimens of *Clio pyramidata*, deviating from the usual f. *lanceolata* (and described below as f. *tyrrhenica* n.f.) are seen. Isolated specimens of these species, as well as the few specimens of *Clio oblonga*, usually still show remnants of or infill with the same limestone. Other specimens in this sample do not show an origin from the limestone, are less opaque and originate presumably from another, unlithified (higher?) part of the bottom sediments.

Additionally, Mr Constantine Mifsud (Malta) donated fossil looking specimens from SW of Malta, MED-ITS2007, sta. G19-2, water depth 460 m, coordinates 35° 31.30' N 14° 05.22' E, a grab sample of bottom sediment in which *Limacina retroversa* is by far the most common species. Also *Clio pyramidata* is abundant, specimens belong partly to f. *tyrrhenica* nov. f. and partly to f. *lanceolata*, with transitional forms present. Among the 13 species present in this sample are 25 specimens of *Cavolinia inflexa* f. *imitans* and 20 of *Diacria trispinosa*, all in the same internal mould preservation.

## Systematics

Lists of synonyms are mainly restricted to the first valid description and to some selected, more recent papers, in which a species is well-described and/or -illustrated. Synonyms and type species are cited literally as given in the paper referred to, inclusive of abbreviations or spelling errors. Without attempting completeness, Mediterranean records in literature are also included in the lists of synonyms with preference, even if only referred to in stratigraphical or palaeoclimatological context. Descriptions of well-known species are usually omitted, the reader is referred to one or more of the recent publications given in the synonyms.

Systematics above genus level are according to Janssen (2003) and Bouchet & Rocroi (2005).



Phylum Mollusca Linnaeus, 1758

Class Gastropoda Cuvier, 1797

Clade Littorinimorpha Golikov & Starobogatov, 1975

Superfamily Pterotracheoidea Rafinesque, 1814

(= 'Heteropoda')

Family Atlantidae Rang, 1829

Genus *Atlanta* Lesueur, 1817

Type species – '*Atlanta Peronii*' (by subsequent designation, de Blainville, 1825: p. 493) = *Atlanta peronii* Lesueur, 1817 (Recent).

Note: Specimens of the genus *Atlanta* occur frequently in the eastern Mediterranean samples. Shells from the Meteor box core and beam trawl samples, always larger than 0.5 mm, are easily recognized and identified to species. Many specimens from the gravity core and the Bologna samples, however, have a diameter of just 0.15-0.6 mm and therefore represent larval shells and frequently even only the first whorls of the larval shell. Therefore an identification of such specimens, especially those from the gravity core, has not been attempted and they are specified below as *Atlanta* sp. (div.). Continued study, however, of later obtained samples, especially those received from Bologna, brought sufficient experience to also recognize most of the very small *Atlanta*-specimens, even if only representing the early protoconch whorls. Many of the *Atlanta*-species recognized nowadays (Seapy, 2011, in Tree of Life website) were traditionally attributed to Souleyet (1852), e.g. by van der Spoel (1976) and many other authors. Recently, however, it was found out (Rosenberg in ICZN, 2009) that Souleyet's atlas in which those species are illustrated with French vernacular names was already published earlier, presumably in 1841. These names were latinized by John Edward Gray (1850), who by doing so became author of those taxa. For details see Janssen & Seapy (2009b).

*Atlanta brunnea* J.E. Gray, 1850  
(Fig. 40A-E)

Atlante brune – Eydoux & Souleyet, [1841]: atlas, pl. 21, figs 15-29.

Atalante brune – M.E. Gray, 1850: p. 46, pl. 242, fig. 5 (copied from Eydoux & Souleyet: pl. 21, fig. 15).

*Atlanta brunnea*, Eydoux, J.E. Gray, 1850: p. 101.

*Atlanta fusca*, Souleyet, 1852: p. 389.

*Atlanta fusca* Souleyet – Issel, 1911: p. 8.

*Atlanta fusca* Souleyet 1852 – Richter, 1968: p. 358, figs 9, 10 (shell), 11 (veliger).

*Atlanta fusca* Souleyet – Di Geronimo, 1970: p. 61, pl. 2, fig. 1a, b.

? *Atlanta* sp. – Colantoni et al., 1970: pl. 26, fig. 10.

*Atlanta fusca* Souleyet –Thiriôt-Quévieux, 1972: p. 561, pl. 7, figs A-G).

*Atlanta fusca* Souleyet – Vatova, 1974: p. 104, pl. 3, fig. B (mala, or mixed up with pl. 2. fig. B?).

*Atlanta fusca* Souleyet, 1852 – van der Spoel, 1976: p. 145, figs 141a-f, 230 (with additional earlier synonyms)

*Atlanta fusca* Souleyet, 1852 – Grecchi, 1984: p. 20, pl. 2, figs 7, 8.

*Atlanta fusca* Souleyet, 1852 – Grecchi & Bertolotti, 1988: p. 122, pl. 2, figs 5, 9, 10.

*Atlanta fusca* Souleyet, 1852 – Seapy, 1990: p. 123, figs 6G, 10A-D.

*Atlanta fusca* Souleyet, 1852 – Richter & Seapy, 1999: p. 634, figs 1A, 6E.

*Atlanta fusca* Souleyet, 1852 – Gofas et al., 2001: p. 192.

*Atlanta brunnea* Gray, 1850 – Giovine in Stoch, 2003: Faunaitalia website.

*Atlanta fusca* Souleyet, 1852 – Janssen, 2007a: p. 146, pl. 2, figs 3-5; pl. 3, figs 1-3.

*Atlanta brunnea* Gray, 1850 – Rosenberg, 2009: Malacolog website.

*Atlanta brunnea* Gray 1850 – Seapy, 2010a: Tree of Life website, 11 figs

*Atlanta brunnea* J.E. Gray, 1850 – WoRMS website, 2011.

*Atlanta fusca* Souleyet 1852 – CLEMAM website, 2011.

## Description

See Seapy (1990, 2010a). Among the Mediterranean *Atlanta*-species, *A. brunnea* is the easiest to recognize. It has a relatively solid shell with a rather high conical protoconch and clear spiral ornament, which make also very juvenile specimens easily recognizable (Fig. 40E). Fully grown specimens from most bottom samples commonly have their reddish-brown colour preserved. In strong magnification the nucleus and early whorls (Fig. 40B-D) appear to be finely granulated. The transition from protoconch to teleoconch is clear by the sudden change in ornament (Fig. 40D). The micro-ornament of this species was also described and nicely illustrated by Thiriôt-Quévieux (1972: pl. 7).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 507/many; Me25-12 Kg2, SMF 332872/1; Me25-13 Kg1, SMF 332881/3; Me25-13 Kg2, SMF 332898/4; Me25-15 Kg1, SMF 332916/79; Me25-15 Kg2, SMF 332935/23; Me25-15 Ku, SMF 332955/12; Me25-16 Kg1, SMF 332971/75; Me25-16 Kg2, SMF 332993/39; Me25-17 Kg1, RGM 569 497/20, SMF 333021/59; Me25-17 Kg2, SMF 333042/11; Me25-18 Kg1, SMF 333061/35; Me25-18 Kg2, SMF 333075/19; Me25-19 Kg1, SMF 333092/20; Me25-19 Kg2, SMF 333109/15; Me25-20 Kg1, SMF 333130/24; Me25-20 Kg2, SMF 333149/26; Me25-20 Ku, SMF 333169/64; Me25-21 Kg1, RGM 569 502/20, SMF 333190/120; Me25-21 Kg2, SMF 333211/18; Me25-22 Kg2, SMF 333229/27; Me25-23 Kg1, SMF 333252/52; Me25-23 Kg2, SMF 333272/64; Me25-23 Ku, SMF 333290/31; Me25-24 Kg1, SMF 333308/6; Me25-24 Kg2, SMF 333323/17; Me25-37 Kg1, RGM 541 608/13, RGM 541 608a/1 (Fig. 40A-D); Me25-37 Ku, SMF 333352/36; Me25-38 Kg1, SMF 333370/10; Me25-38 Ku, SMF 333388/1; Me25-39 Kg1, SMF 333402/10; Me25-39 Kg2, SMF 333420/16.

Gravity core T87/2/20G (Eemian): sample 2.47-2.48 m,



RGM 569 095a/3; 2.45-2.46 m, RGM 569 097/1 protoconch; 2.42-2.43 m, RGM 569 101/8 protoconchs; 2.36-2.37 m, RGM 569 120/25 protoconchs, RGM 569 120a/1 protoconch (Fig. 40E); 2.33-2.34 m, RGM 569 147/2 protoconchs; 2.30-2.31 m, RGM 569 181a/2; 2.24-2.25 m, RGM 569 182/19; 2.21-2.22 m, RGM 569 226/3 protoconchs; 2.16-2.17 m, RGM 569 254a/1.

Gravity core T87/2/20G (Holocene), sample 0.05-0.06 m, RGM 569 392/1.

Bologna samples: CJ 72 III-20, RGM 570 404/1; CJ 72 III-21 (bottom), RGM 570 739/1, 9 juveniles; CJ 72 III-22, MZB (ex RGM 570 638)/1, 3 juveniles; CJ 72 III-25 (top), RGM 570 522/2 protoconchs; CR 20, RGM 570 377/5; CR 33, MZB (ex RGM 569 779)/3 juveniles; CR 34, RGM 570 660/1 juvenile; CR 39, RGM 570 601/8, 8 juveniles; CR 42, RGM 570 343/8; CR 68, RGM 570 708/10, 28 juveniles; CR 70, RGM 570 550/2, 6 protoconchs; J 74-9, RGM 570 485/1, c. 30 juveniles; J 74-12, RGM 569 809/4 juveniles; T74-65-1, RGM 570 938/many (mainly juveniles); T74-65-2, RGM 570 877/5, c. 35 juveniles.

## Discussion

*Atlanta brunnea*, in literature usually referred to as *A. fusca* Souleyet, is a common species, present in almost all box core and beam trawl, as well as in most of the Bologna samples from the Ionian and Tyrrhenian seas, sometimes in rather large numbers. Even among the very small-sized specimens from the gravity core some protoconchs could be recognized by their peculiar shape and ornament. In the core this species was relatively common (Tab. 3b) in the Eemian interval between the sapropels S5 and S4, occurring in numbers between zero and 26 per sample; a single further specimen was only present in the uppermost Holocene sample.

CLEMAM (2011) still claims '*Atlanta fusca* Souleyet, 1852' to be the valid name of this species, and '*A. brunnea* Gray 1850' its 'dubious!' synonym.

### *Atlanta helicinoidea* J.E. Gray, 1850

Atlante helicinoide – Eydoux & Souleyet [1841]: atlas, pl. 20. figs 23-30.

? Atlante déprimée – Eydoux & Souleyet [1841]: atlas, pl. 20. figs 31-37.

Atalante Helicinoide – M.E. Gray, 1850: p. 46, pl. 242, fig. 2, 2a (copied from Eydoux & Souleyet: pl. 20).

? Atalante déprimée – M.E. Gray, 1850: p. 46, pl. 242, fig. 4 (copied from Eydoux & Souleyet: pl. 20).

*Atlanta helicinoidea*, Eydoux, J.E. Gray, 1850: p. 101.

? *Atlanta depressa*, Eydoux, J.E. Gray, 1850: p. 101.

*Atlanta helicinoides*, Souleyet, 1852: p. 384.

? *Atlanta depressa*, Souleyet, 1852: p. 385.

*Atlanta helicinoides* Souleyet – Franc, 1949: p. 214, figs 7-11.

*Atlanta helicinoides* Souleyet, 1852 – van der Spoel, 1976: p. 144, fig. 140a, b, 230 (with additional synonyms).

*Atlanta helicinoides* Souleyet 1852 – Richter, 1987: p. 179, pl. 1, figs 5, 6; pl. 2, figs 15, 16; pl. 4, figs 31-32; pl. 5. figs 33, 40; pl. 6, figs 43, 44, 51, 52, 54; pl. 7, figs 58-60.

*Atlanta helicinoides* Souleyet, 1852 – Grecchi & Bertolotti: 1988: p. 121, pl. 2, fig. 4.

*Atlanta helicinoides* Souleyet, 1852 – Seapy, 1990: p. 126, figs 1C, 2C, 6J, 11E-H.

*Atlanta helicinoides* Souleyet, 1852 – Richter & Seapy, 1999: p. 636, fig. 6A.

*Atlanta helicinoides* Souleyet, 1852 – Gofas et al., 2001: p. 192.

*Atlanta helicinoides* Souleyet, 1852 – Giovine in Stoch, 2003: Faunaitalia website.

*Atlanta helicinoides* Souleyet, 1852 – Janssen, 2007a: p. 146, pl. 3, figs 4-6; pl. 4, figs 1-5.

*Atlanta helicinoidea* Gray, 1850 – Rosenberg, 2009, Malacolog website.

*Atlanta helicinoidea* Gray 1850 – Seapy, 2010a, Tree of Life website, 15 figs

*Atlanta helicinoidea* J.E. Gray, 1850 – WoRMS website, 2011.

*Atlanta helicinoides* Souleyet 1852 – CLEMAM website, 2011.

## Description

See Richter (1987) and Seapy (1990, 2010a). Just a few specimens, the largest semiadult (SMF 332994), differ from *Atlanta selvagensis* in having  $4\frac{1}{4}$  protoconch whorls instead of  $3\frac{1}{4}$ - $3\frac{3}{4}$  and thus it is the fifth whorl increasing rapidly in width. The whorls of the larval shells have a spiral ornament, which is, however, weaker than in typical specimens of this species, only the two juveniles from sample Me51/3-562 (DCS) have the normal ornament for this species. According to Richter (1987: p. 181, compare his pl. 3, fig. 27), however, the strenght of the spiral sculpture is variable in this species.

## Material examined

Box core and beam trawl samples: Me25-16 Kg2, SMF 332994/1; Me51/3-562, DCS RGA801/2 protoconchs.

Bologna samples (all protoconchs): CJ 72 III-21 (bottom), RGM 570 740/2; CJ 72 III-25 (top), RGM 570 523/3; CR 39, RGM 570 602/11; CR 42, RGM 570 344/1; CR 68, RGM 570 709/4; J 74-9, RGM 570 593/2.

## Discussion

*Atlanta helicinoidea* has not yet been recorded from the eastern Mediterranean ('nicht im zentralen und östl. Mittelmeer'; Richter, 1987: p. 179). This seems to be acknowledged by the present very few, probably drifted specimens, a reproducing population obviously is or has been absent. The specimens are all opaque and, although well-preserved, do not look very fresh. They are too few in number to document a healthy, former population of this species in the Levantine basin.

*Atlanta depressa* J.E. Gray, 1850 was considered (but with a query) to be an unornamented specimen of '*A. helicinoides*' by Tesch (1946: p. 20); also Rosenberg (2009) gives *A. depressa* as a synonym of the present species. Van der Spoel (1976: p. 145), however, considered it a



probable synonym of *A. echinogyra* Richter, 1972. As no syntypes seem to be in existence (J.E. Gray, 1855: p. 14; van der Spoel, 1976: p. 207ff) the question is doomed to remain unanswered. CLEMAM (2011) still claims '*Atlanta helicinoides* Souleyet, 1852' to be the valid name of this species.

*Atlanta lesueurii* J.E. Gray, 1850  
(Fig. 42A, B)

Atlante de Lesueur – Eydoux & Souleyet [1841]: atlas, pl. 20, figs 1-8.

Atalante de Lesueur – M.E. Gray, 1850: p. 46, pl. 241, fig. 5 (copied from Eydoux & Souleyet, pl. 20).

*Atlanta Lesueurii*, Eydoux, J.E. Gray, 1850: p. 101.

*Atlanta Lesueurii*, Souleyet, 1852: p. 380.

*Atlanta primitia* (Gould) – Couthouy in Gould, 1852: p. 491.

*Atlanta primitia* – Gould, 1856: pl. 51: fig. 597.

*Atlanta Lesueuri* Souleyet – Issel, 1911: p. 6.

*Atlantqa lesueurii* Souleyet 1852 – Richter, 1968: p. 355, figs 5, 6a.

*Atlanta lesueuri* Souleyet – Di Geronimo, 1970: p. 58, pl. 1, fig. 3°, b.

? *Atlanta lesueuri* Souleyet – Vatova, 1974: p. 102, pl. 2, fig. B (*mala*, or mixed up with pl. 3, fig. B?) (excl. synonymy).

*Atlanta lesueuri* Souleyet, 1852 – van der Spoel, 1976: p. 143, fig. 138 (*pars*, includes *Atlanta oligogyra*).

*Atlanta lesueuri* Souleyet 1852 – Richter, 1986: p. 21, text-fig. 1, pl. 1, figs 1, 2 (shells); pl. 2, figs 5, 9-14 (radula).

*Atlanta lesueuri* Souleyet, 1852 – Seapy, 1990: p. 118, figs 5B, 6A, 7A-D.

*Atlanta lesueuri* Souleyet, 1852 – Richter & Seapy, 1999: p. 636, figs 1C, 6C.

*Atlanta lesueurii* Souleyet, 1852 – Gofas et al., 2001: p. 192.

*Atlanta lesueurii* Souleyet, 1852 – Giovine, in Stoch, 2003: Faunaitalia website.

*Atlanta lesueuri* Souleyet, 1852 – Janssen, 2007a: p. 147, pl. 5, figs 6, 7; pl. 6, figs 1-3.

*Atlanta lesueurii* Gray 1850 – Rosenberg, 2009: Malacolog website.

*Atlanta lesueurii* Gray, 1850 – Seapy, 2010a: Tree of Life website, 7 figs.

*Atlanta lesueurii* J.E. Gray, 1850 – WoRMS website, 2011.

*Atlanta lesueurii* Souleyet 1852 – CLEMAM website, 2011.

## Description

See Seapy (1990, 2010a).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 508/1; Me25-17 Kg2, SMF 333044/1; Me25-19 Kg2, SMF 333111/4; Me25-24 Kg2, SMF 333324/1; Me25-37 Kg1, RGM 541 609/18, RGM 541 609a/1 (Fig. 42A, B); Me25-38 Kg1, SMF 333372/1.

Bologna samples: CR 20, RGM 570 378/5; CR 31, RGM 570 459/5; CR 34, RGM 570 661/many; CR 39, RGM 570 603/many; CR 42, RGM 570 345/5; CR 68, RGM 570 710/many juveniles; J 73-17, RGM 570 632/1.

## Discussion

Van der Spoel (1976: p. 143) included *Atlanta oligogyra* Tesch, 1906 in the synonymy of the present species, discussing only in his opinion insufficient 'discriminating characters' of shell colour and soft parts. The two species, however, differ clearly in the shape of the initial whorls, as was nicely illustrated by Seapy (1990: p. 118, fig. 7; 2009). These differences were not noted by van der Spoel, although the type material of Tesch's species was housed in his own institute, in Amsterdam.

ICZN (2009, Opinion 2216) ruled that the name *Atlanta lesueurii* J.E. Gray, 1850 is not invalid by reason of being a junior primary homonym of the pteropod *Atlanta lesueurii* d'Orbigny, 1835 (a fact already noted by Giovine, 1987). The name *A. lesueurii* J.E. Gray is placed on the Official List of Specific Names in Zoology. The taxon *A. lesueurii* d'Orbigny is nowadays included in the Limacinidae, as *Limacina lesueurii* (see below).

Vatova (1974) mentioned few specimens of this species from bottom samples in the Ionian Sea. His three illustrations, however, are incorrect: the spire is indicated far too high, with spiral ornament, and the shape of the body whorl is also erroneous; it might very well be that the drawing is mixed up with the one for '*Atlanta fusca*', his pl. 3, fig. B).

*Atlanta peronii* Lesueur, 1817  
(Figs 2, 4, 5, 42C, D)

Corne d'Ammon – Lamanon, 1797: p. 134, pl. 63, figs 1-4.

*A[tlanta] Peronii*, Lesueur, 1817c: p. 390, pl. 2, figs 1, 1-2.

*A[tlanta] Keraudrenii*, Lesueur, 1817c: p. 391.

*Steira lamanoni*, Eschscholtz, 1825: p. 735, fig. 3.

*Atlanta peronii* – Cantraine, 1841: p. 39, pl. 1, fig. 1.

*Atlanta Peronii* – Sowerby in Reeve & Sowerby, 1878: pl. 3, fig. 20a, b.

*Atlanta peronii* Les. – Oberwimmer, 1898: p. 587.

? *Atlanta rosea* Soul. – Oberwimmer, 1898: p. 587.

*Atlanta steindachneri* Oberwimmer, 1898: p. 587, figs 1-2.

*Atlanta Peroni* Lesueur – Issel, 1911: p. 5, figs 6-10.

*Atlanta peroni* Lesueur – van Straaten, 1966: p. 431.

*Atlanta peronii* Lesueur 1817 – Richter, 1968: p. 357, figs 6b, 7, 14 (shell), 8 (veliger).

*Atlanta peroni* (Rang) – Blanc-Vernet et al., 1969: p. 220.

*Atlanta peroni* Lesueur – Di Geronimo, 1970: p. 55, pl. 1, fig. 2a, b.

*Schizotrochus palaeomphaloides*, Nordsieck, 1973: p. 4, fig. 1.

? *Atlanta cf peroni* (Lesuer, 1817) [sic] – Nordsieck, 1973: p. 4, fig. 13.

*Atlanta peroni* Lesueur – Vatova, 1974: p. 102 pl. 2, fig. A (*mala*).



*Atlanta peroni* Lesueur, 1817 – van der Spoel, 1976: p. 141, fig. 135.

*Atlanta peroni* Lesueur, 1817 – Grecchi, 1984: p. 19, pl. 1, fig. 19 (*partim*, non pl. 2, figs 1, 2 = *Atlanta inflata*).

*Atlanta peroni* Lesueur, 1817 – Grecchi & Bertolotti, 1988: p. 120, pl. 2, fig. 3.

*Atlanta peroni* Lesueur, 1817 – Seapy, 1990: p. 118, figs 4E-H, 6C.

*Atlanta peroni* Lesueur 1817 – Richter, 1993: p. 190, pl. 1, fig. 1; pl. 2, fig. 5 (shells); pl. 4, figs 16, 17, 19 (radula).

*Atlanta peroni* Lesueur, 1817 – Richter & Seapy, 1999: p. 638, figs 1D, 7B.

*Atlanta peronii* Lesueur, 1817 – Gofas et al., 2001: p. 192.

*Atlanta peronii* Lesueur, 1817 – Giovine, in Stoch, 2003: Faunaitalia website.

*Atlanta peronii* Lesueur, 1817 – Rosenberg, 2009: Malacolog website.

*Atlanta peronii* Lesueur 1817 – Seapy, 2010a: Tree of Life website, 9 figs.

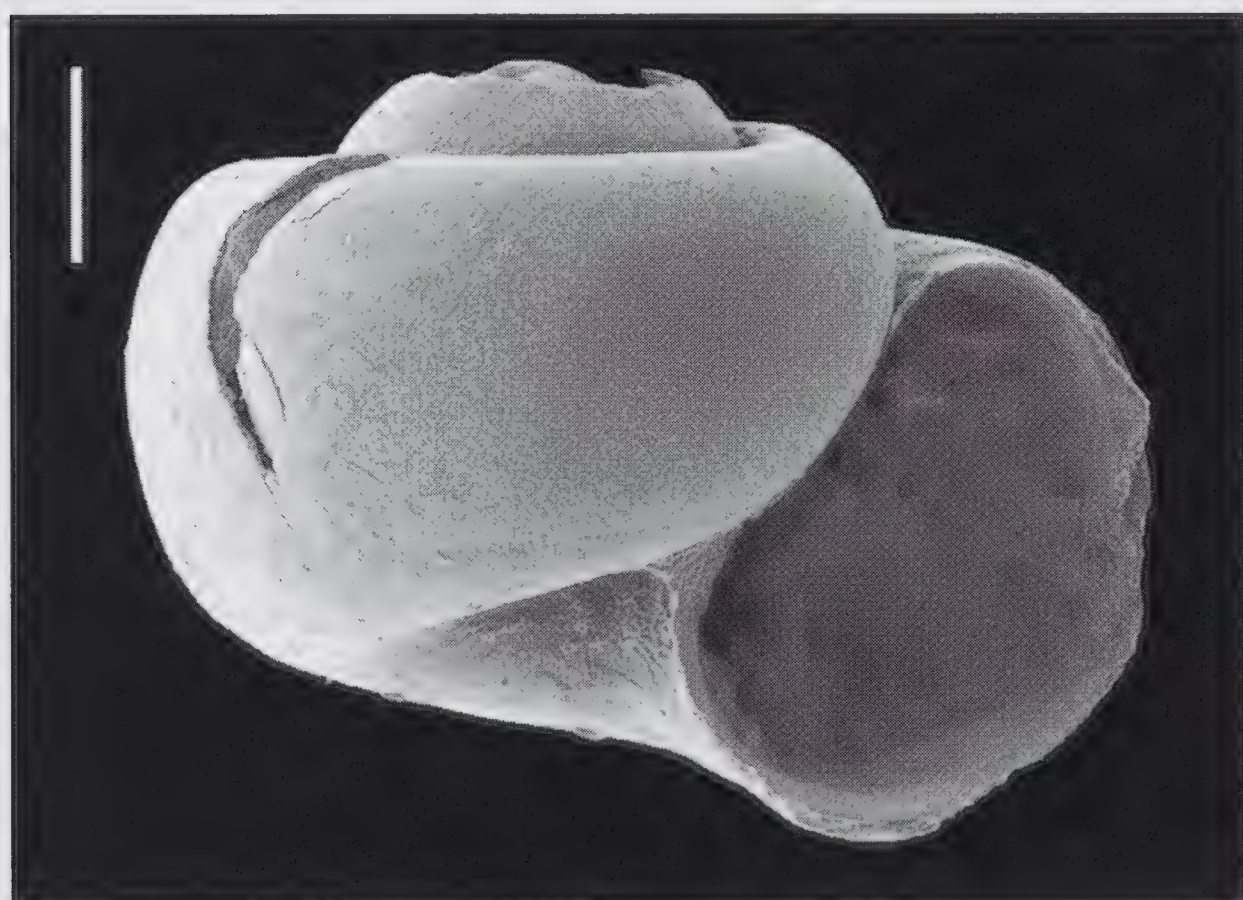
*Atlanta peronii* Lesueur, 1817 – WoRMS website, 2011.

*Scissurella palaeomphaloides* Nordsieck, 1974 [*sic*] – WoRMS website, 2011 (incorrectly as a junior synonym of *Anatoma crispata* (Fleming, 1828))

*Atlanta peronii* Lesueur 1817 – CLEMAM website, 2011.

## Description

See Seapy (1990, 2010a). This is by far the largest species of this genus and fully grown individuals are therefore easily recognizable. Among the juvenile specimens of *Atlanta* occurring in the Mediterranean an identification is more difficult. Specimens of c. 3-3½ whorls (**Fig. 2**) or slightly less are recognizable by their rounded rectangular shape when seen in frontal view (see also Grecchi & Bertolotti, 1988: pl. 2, fig. 3). Such smaller specimens may resemble equally sized juveniles of *Protatlanta souleyeti* strongly (**Fig. 3**). The latter, however, have a more naticoid shape and the bodywhorl is not shouldered. Still, the variability among juveniles of these species makes recognition sometimes problematic.



**Fig. 2.** Larval shell of *Atlanta peronii* Rang, 1817. RGM 570 741a, sample CJ 72III-21 (bottom), apertural view. Bar length is 100 µm.

**Fig. 2.** Conchiglia larvale di *Atlanta peronii* Rang, 1817. RGM 570 741a, campione CJ 72III-21 (base), vista aperturale. Scala = 100 µm.



**Fig. 3.** Larval shell of *Protatlanta souleyeti* (Smith, 1888). RGM 570 489a, sample J74-9, apertural view. Bar length is 100 µm.

**Fig. 3.** Conchiglia larvale di *Protatlanta souleyeti* (Smith, 1888). RGM 570 489a, campione J74-9, vista aperturale. Scala = 100 µm.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 509/many, RGM 569 510/4 juveniles; Me25-13 Kg1, SMF 332883/2; Me25-13 Kg2, SMF 332899/1; Me25-15 Kg1, SMF 332918/29; Me25-15 Kg2, SMF 332937/65; Me25-15 Ku, SMF 332957/7; Me25-16 Kg1, SMF 332973/6; Me25-16 Kg2, SMF 332996/13; Me25-17 Kg1, SMF 333023/13; Me25-17 Kg2, SMF 333045/9; Me25-18 Kg1, SMF 333063/3; Me25-18 Kg2, SMF 333077/4; Me25-19 Kg1, SMF 333093/8; Me25-19 Kg2, SMF 333112/19; Me25-20 Kg1, SMF 333132/1; Me25-20 Kg2, SMF 333151/3; Me25-20 Ku, SMF 333171/14; Me25-21 Kg1, SMF 333192/31; Me25-21 Kg2, SMF 333213/52; Me25-22 Kg2, SMF 333231/17; Me25-23 Kg1, SMF 333254/27; Me25-23 Kg2, SMF 333274/16; Me25-23 Ku, SMF 333292/30; Me25-24 Kg1, SMF 333309/2; Me25-24 Kg2, SMF 333325/10; Me25-24 Ku, SMF 333341/1; Me25-37 Kg1, RGM 541 610/373, RGM 541 610a (**Fig. 42C, D**); Me25-37 Ku, SMF 333354/39; Me25-38 Kg1, SMF 333373/27; Me25-38 Ku, SMF 333389/9; Me25-39 Kg1, SMF 333404/19; Me25-39 Kg2, SMF 333422/9.

Bologna samples: CJ 72 III-21, RGM 570 442/many; CJ 72 III-21 (bottom), RGM 570 741/25 juveniles; CJ 72 III-23, RGM 570 421/1; CJ 72 III-25 (top), RGM 570 524/c. 40 juveniles; CJ 72 III-27 (centre), RGM 570 684/1 juvenile; CR 20, RGM 570 379/26; CR 31, RGM 570 460/1, 6 juveniles; CR 33, MZB (ex RGM 569 780)/7 juveniles; CR 34, RGM 570 662/9 juveniles; CR 39, RGM 570 604/many; CR 42, RGM 570 346/29, RGM 570 347/c. 35 juveniles; CR 68, RGM 570 711/many juveniles; CR 70, RGM 570 551/3, 30 juveniles; J 74-9, RGM 570 486/many; J 74-10, RGM 569 903/4 juveniles; J 74-12, RGM 569 810/3, 35 juveniles, RGM 569 811/1; T74-55-6, RGM 570 910/22 juveniles; T74-65-1, RGM 570 939/many (mainly juveniles); T74-65-2, RGM 570 878/many juveniles; T74-65-9, RGM 570 929/1 juvenile, 3 fragments; T74-65-10, RGM 570 859/20.



## Discussion

For a discussion on the identity of *Steira lamanoni* Eschscholtz, 1825 see below, under *Protatlanta souleyeti*. Holotype and paratype (SMF 336131-336132) of the taxon *Schizotrochus palaeomphaloides* Nordsieck, 1973 could be studied thanks to cooperation of Dr Ronald Janssen (SMF). Both agree completely with the numerous juvenile specimens of *Atlanta peronii* in the present material. Ramazzotti et al. (2007) list Nordsieck's taxon as a synonym of *Protatlanta souleyeti*.

*Atlanta peronii* was reported from numerous stations in the Adriatic and the Levantine Basin, both dead and alive, by Oberwimmer (1898). The same author mentioned also specimens of *A. rosea* and *A. steindachneri* from a large number of stations in the eastern Mediterranean (not in the Adriatic). *Atlanta rosea* used to be considered a synonym of *A. peronii* (see van der Spoel, 1976), but Richter (1993) considered it a separate species. As Oberwimmer did not give a description or illustration and as this species has not yet been recorded from the Mediterranean with certainty I include this reference with a query. *Atlanta steindachneri* Oberwimmer, according to the original description and illustration, represents a specimen of *A. peronii* in which the ultimate half of the body whorl is so strongly separated from the preceding one that the keel does not completely fill the space.

Vatova (1974) recorded this species as common in four bottom samples from the Ionian Sea. The illustrations, however, are completely incorrect (in his drawings the keel does not penetrate between the body whorl and the penultimate one, the spire is far too high, and the larval whorls are drawn as being irregular and with spiral ornament).

See also the discussion below, under *Oxygyrus inflatus*.

### *Atlanta selvagensis* de Vera & Seapy, 2006 (Fig. 41A-R)

? *Atlanta cordiformis* Gabb, n.s., Gabb, 1873: p. 201.

? *Atlanta cordiformis* Gabb – Guppy, 1882: p. 175.

*Atlanta quoyana* Soul. – Oberwimmer, 1898: p. 587.

*Atlanta inflata* Souleyet – Issel, 1911: p. 7 (non Souleyet).

? *Atlanta cordiformis* Gabb – Pilsbry, 1922: p. 315, fig. 14.

*Atlanta inflata* Souleyet 1852 – Richter, 1968: p. 351, figs 1, 2 (shell), 3a, b (radula), 4 (veliger) (non Souleyet).

? *Atlanta peresi* Frontier – Thiriot-Quiévreux, 1969: p. 354.

*Atlanta inflata* Souleyet – Di Geronimo, 1970: p. 59, pl. 2, fig. 2a, b (non Souleyet).

*Atlanta inflata* Souleyet 1852 – Richter, 1974: p. 62, text-fig. 8b; pl. 1, fig. 4 (non Souleyet).

*Atlanta inflata* Souleyet – Vatova, 1974: p. 104, pl. 3, fig. A (non Souleyet).

*Atlanta inflata* Souleyet, 1852 – Grecchi, 1984: p. 20, pl. 2, figs 4, 5 (non Souleyet).

*Atlanta peroni* (Lesueur, 1817) – Grecchi, 1984: p. 19, pl. 2, figs 1, 2 (partim, non Lesueur).

*Atlanta inflata* Souleyet, 1852 – Grecchi & Bertolotti, 1988: p. 122, pl. 2, fig. 13, 14.

*Atlanta inflata* Souleyet, 1852 – Richter & Seapy, 1999: p. 636 (partim, Atlantic, Mediterranean and Indian Ocean specimens only) (non Souleyet).

? *Atlanta cordiformis* Gabb, 1873 – Janssen, 1999: p. 11, pl. 2, figs 1, 2.

*Atlanta inflata* Souleyet, 1852 – Gofas et al., 2001: p. 192 (non Souleyet).

*Atlanta inflata* Souleyet, 1852 – Rolán et al., 2005: p. 101, figs 429-430 (non Souleyet).

*Atlanta selvagensis* de Vera & Seapy, 2006: p. 48, fig. 2A-D (non fig. 2E, F = *Atlanta plana*), fig. 3A-D.

*Atlanta inflata*?, *Atlanta selvagensis* de Vera & Seapy, 2006 – Janssen & Seapy, 2009b: p. 139ff, figs 8-12.

*Atlanta inflata* Gray, 1850 – Rosenberg, 2009: Malacolog website (non J.E. Gray).

*Atlanta selvagensis* de Vera and Seapy 2006 – Seapy, 2010a: Tree of Life website, 13 figs.

*Atlanta selvagensis* de Vera & Seapy, 2006 – WoRMS website, 2011.

*Atlanta selvagensis* de Vera & Seapy 2006 – CLEMAM website, 2011.

## Description

See de Vera & Seapy (2006) and Janssen & Seapy (2009b).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 511/241, RGM 569 512/17 juveniles; Me25-13 Kg1, SMF 332882/2; Me25-15 Kg1, RGM 569 486/3; SMF 332917/11, Me25-15 Kg2, SMF 332936/4; Me25-15 Ku, SMF 332956/1; Me25-16 Kg1, SMF 332972/9; Me25-16 Kg2, SMF 332995/8; Me25-17 Kg1, SMF 333022/7; Me25-17 Kg2, SMF 333043/6; Me25-18 Kg1, SMF 333062/1; Me25-18 Kg2, SMF 333076/1; Me25-19 Kg2, SMF 333110/9; Me25-20 Kg1, SMF 333131/4; Me25-20 Kg2, SMF 333150/9; Me25-20 Ku, SMF 333170/8; Me25-21 Kg1, SMF 333191/11; Me25-21 Kg2, SMF 333212/3; Me25-22 Kg2, SMF 333230/3; Me25-23 Kg1, SMF 333253/3; Me25-23 Kg2, SMF 333273/2; Me25-23 Ku, SMF 333291/2; Me25-37 Kg1, RGM 541 611/6 (Fig. 41A-R); Me25-37 Ku, SMF 333353/5; Me25-38 Kg1, SMF 333371/2; Me25-39 Kg1, SMF 333403/3; Me25-39 Kg2, SMF 333421/8.

Bologna samples: CJ 72 III-21, RGM 570 443/2; CJ 72 III-21 (bottom), RGM 570 742/7, many juveniles; CJ 72 III-22, MZB (ex RGM 570 639)/24 juveniles; CJ 72 III-25 (top), RGM 570 525/many; CJ 72 III-27 (centre), RGM 570 685/19 juveniles; CR 20, RGM 570 380/many, RGM 570 381/many juveniles; CR 31, RGM 570 461/11; CR 33, MZB (ex RGM 569 781)/5; CR 34, RGM 570 663/many juveniles; CR 39, RGM 570 605/many; CR 42, RGM 570 348/many, RGM 570 349/many juveniles; CR 68, RGM 570 712/many; CR 70, RGM 570 552/many; J 74-9, RGM 570 487/many; J 74-10, RGM 569 904/30 juveniles; J 74-12, RGM 569 812/12, 50 juveniles; T74-55-6,



RGM 570 911/many juveniles; T74-65-1, RGM 570 940/many (mainly juveniles)); T74-65-2, RGM 570 879/many juveniles.

## Discussion

This small and in the eastern Mediterranean samples commonly occurring atlantid used to be identified, following papers by Tesch (1908), Richter (1968, 1974) and Richter & Seapy (1999) as *Atlanta inflata*. Recently, however, Janssen & Seapy (2009b) demonstrated that the Atlantic (inclusive of the Mediterranean) and Indian Ocean *Atlanta* that used to be indicated as *A. inflata* does not belong to that species but agrees with the species *A. selvagensis*. The most important difference in shell morphology is the number of larval whorls, which is larger in typical *A. inflata*, a species restricted to the Pacific Ocean. An extensive comparison between those two taxa is given in Janssen & Seapy (2009b) and demonstrated by a number of SEM images.

There is, however, a fossil species, *Atlanta cordiformis* Gabb, 1873, described from the 'Miocene' of the Dominican Republic, which might be an older name for *A. selvagensis*. *Atlanta cordiformis* was not illustrated in the original publication. Pilsbry (1922) referred to three syntypes in the collections of the Academy of Natural Sciences in Philadelphia and was the first to give drawings of the 'type'. The same specimen was reillustrated by Janssen (1999: pl. 2, fig. 1a-c), together with a poorly preserved additional specimen (not a syntype). In this latter paper I stated that '... *A. inflata* Souleyet, 1852 is especially close to *A. cordiformis*. Such is the resemblance that I consider them to be synonymous'. In that paper, however, I decided to maintain Gabb's name for the fossil species, as the available material is too limited and there also is a considerable age difference. At that time I used Atlantic material of what I considered to be *A. inflata* for a comparison. Another look at the available illustrations made clear that the drawing of Pilsbry (1922), as well as that of Janssen (1999), clearly representing the same specimen by the way, demonstrate convincingly that the whorl that widens rapidly is the fourth, which agrees with *A. selvagensis*, and not with *A. inflata*, as in the latter species it is the fifth whorl widening rapidly. This strongly supports the possibility that the name *A. cordiformis* is a senior synonym of *A. selvagensis*. Still, I hesitate: we do not have any information, of course, on the soft parts (eyes and/or radula) or on the coloration in the shell of the fossil species, and the fossil material is very poor, both in preservation and in number of specimens. In my 1999 drawings I did not include spiral ornament on the initial whorls, nor mentioned it in the description, but also in Recent samples of *A. selvagensis* specimens lacking spirals occur. The keel of the lectotype of *A. cordiformis* is incompletely preserved, but what remains is not necessarily contradicting the existence of a truncated leading edge, as in *A. selvagensis* and also the size of the lectotype ( $W = \sim 1.5$  mm) agrees. Summariz-

ing, I have to conclude that *A. cordiformis* presumably is the same as *A. selvagensis*, but for reasons of certainty I prefer to see more material before formally declaring *A. selvagensis* a junior subjective synonym.

Rosenberg (2009) cited *Atlanta quoyana* Souleyet, 1852, as well as its senior synonym *A. quoyii* J.E. Gray, 1850, both as synonyms of *A. inflata*. This seems to be correct indeed, as the *A. quoyana* type locality is the Pacific Ocean. Records of *A. quoyana* from the Mediterranean (Oberwimmer, 1898) most probably represent *A. selvagensis*. He reported *A. quoyana* dead and alive from a number of stations in the eastern Mediterranean, but did not find it in the Adriatic.

## *Atlanta* sp. div. (Fig. 40F-I)

### Material examined

Gravity core T87/2/20G (Saalian), sample 2.81-2.82 m, RGM 569 079a/9, RGM 569 079b/1.

Gravity core T87/2/20G (Eemian), sample 2.785-2.795 m, RGM 569 080/267; 2.73-2.74 m, RGM 569 086a/490; 2.67-2.68 m, RGM 569 087a/235; 2.63-2.64 m, RGM 569 089a/66; 2.59-2.60 m, RGM 569 091a/71; 2.54-2.55 m, RGM 569 092a/49; 2.49-2.50 m, RGM 569 093a/18; 2.47-2.48 m, RGM 569 095b/263; 2.45-2.46 m, RGM 569 100a/35; 2.42-2.43 m, RGM 569 119a/133; 2.36-2.37 m, RGM 569 121/207; RGM 569 121a/1 (Fig. 40F), RGM 569 121b/1 (Fig. 40G), RGM 569 121c/1 (Fig. 40H); 2.33-2.34 m, RGM 569 165a/113; 2.30-2.31 m, RGM 569 181b/128; 2.24-2.25 m, RGM 569/155, RGM 569 183a/1 (Fig. 40I); 2.21-2.22 m, RGM 569 203/136; 2.18-2.19 m, RGM 569 242a/199; 2.16-2.17 m, RGM 569 254b/256; 2.14-2.15 m, RGM 569 266a/78; 2.14-2.15 m, RGM 569 271a/32; 2.03-2.04 m, RGM 569 284a/78; 1.97-1.98 m, RGM 569 292a/63; 1.91-1.92 m, RGM 569 300a/62; 1.79-1.80 m, RGM 569 303a/5; 1.76-1.77 m, RGM 569 304a/2; 1.72-1.73 m, RGM 569 305a/31; 1.72-1.73 m, RGM 569 313a/157; 1.68-1.69 m, RGM 569 324a/272; 1.65-1.66 m, RGM 569 326a/27; 1.61-1.62 m, RGM 569 327a/6; 1.60-1.61 m, RGM 569 328a/4.

Gravity core T87/2/20G (Weichselian), sample 1.58-1.59 m, RGM 569 329a/3; 1.53-1.54 m, RGM 569 330a/19; 1.48-1.49 m, RGM 569 331a/19; 1.43-1.44 m, RGM 569 332a/12; 1.33-1.34 m, RGM 569 333a/9; 1.03-1.04 m, RGM 569 337a/2; 0.93-0.94 m, RGM 569 340a/4; 0.89-0.90 m, RGM 569 341a/5; 0.87-0.88 m, RGM 569 342a/3; 0.80-0.81 m, RGM 569 344a/6; 0.77-0.78 m, RGM 569 345a/4; 0.75-0.76 m, RGM 569 346a/3; 0.72-0.73 m, RGM 569 347a/4; 0.70-0.71 m, RGM 569 348a/2; 0.65-0.66 m, RGM 569 349a/2; 0.60-0.61 m, RGM 569 350a/1; 0.55-0.56 m, RGM 569 351a/6; 0.50-0.51 m, RGM 569 352a/3; 0.45-0.46 m, RGM 569 353a/1; 0.40-0.41 m, RGM 569 354a/1; 0.35-0.36 m, RGM 569 355a/6; 0.30-0.3.

Gravity core T87/2/20G (Holocene), sample 0.22-0.23 m, RGM 569 366a/93; 0.20-0.21 m, RGM 569 367a/66; 0.19-0.20 m, RGM 569 368a/34; 0.18-0.19 m, RGM 569 369a/81; 0.17-0.18 m, RGM 569 373a/122; 0.16-0.17 m, RGM 569 374a/85; 0.14-0.15 m, RGM 569 375a/183;



0.12-0.13 m, RGM 569 383a/173; 0.11-0.12 m, RGM 569 389a/56; 0.095-0.105 m, RGM 569 391a/25; 0.05-0.06 m, RGM 569 407a/77.

Bologna samples: CJ 72 III-20, RGM 570 405/many; CR 33, MZB (ex RGM 569 782)/18; CR 70, RGM 570 553/many; J 73-29, RGM 570 427/6; J 74-9, RGM 570 488/many.

## Discussion

Without exception these are very small, larval shells in premetamorphosis stage that could not be identified with an acceptional degree of certainty. A profound study by means of SEM imaging would be necessary, which is a practical impossibility for the large number of specimens. Some specimens from this material are illustrated here. Most specimens originate from the gravity core.

### Genus *Oxygyrus* Benson, 1835

Type species – *Oxygyrus inflatus* Benson, 1835 (by monotypy). J.E. Gray (1847: p. 149) cited *Atlanta Keraudrenii* Rang as type species, which is incorrect as that name does not occur in Benson's paper.

### *Oxygyrus inflatus* Benson, 1835 (Figs 42E-H5, 43A, B)

non *A[tlanta] Keraudrenii* Lesueur, 1817c: p. 391 (= *Atlanta peronii*, see below).

*Atlanta Keraudrenii* Lesueur – Rang, 1827: p. 380, pl. 9, figs 4-6, 8 (non Lesueur).

*Atlanta Keraudrenii* Lesueur – Rang, 1832: Classe 5, pl. 4, figs 1-7 (non Lesueur).

*Atlanta Keraudrenii* Lesueur – d'Orbigny, 1834: pl. 11, figs 16-23 (non Lesueur).

*Atlanta (Helicophlegma) Keraudrenii* – d'Orbigny, 1835: p. 169 (non *A. keraudrenii* Lesueur).

*Atlanta Keraudrenii* Lesueur – d'Orbigny, 1835: p. 169 (non Lesueur).

*Atlanta Keraudrenii* Lesueur – d'Orbigny, 1835: pl. 20, figs 3, 4 (non Lesueur).

*Oxygyrus inflatus* Benson, 1835: p. 176.

Atlante de Keraudren – Eydoux & Souleyet, [1841]: pl. 18, fig. 1-17.

Atlante de Rang – Eydoux & Souleyet, [1841]: pl. 18, figs 18-24.

*Ladas keraudrenii* – Cantraine, 1841: p. 38, pl. 1, figs 2, 2a, b.

*Oxygyrus Keraudrenii* – Gray, 1850: p. 101 (non *A. keraudrenii* Lesueur).

*Oxygyrus Rangii* – Gray, 1850: p. 101.

*Atlanta Keraudrenii*, Lesueur – Souleyet, 1852: p. 364 (non Lesueur).

*Atlanta Rangii*, nobis – Souleyet, 1852: p. 369.

*Atlanta Keraudrenii*, Les. – Vérany, 1853: p. 381.

*Oxygyrus Keraudrenii*, Rang – Woodward, 1854: p. 201, pl. 14, fig. 24, 25.

*Atlanta (Oxygyrus) Kerandreni [sic]* – Sowerby in Reeve & Sowerby, 1878: pl. 3, fig. 21a, b.

*Oxygyrus keraudrenii* – Smith, 1888: p. 46 (with extensive synonymy) (non *A. keraudrenii* Lesueur).

*Oxygyrus Keraudrenii*, Rang – Woodward, 1890: p. 344, pl. 14, figs 24, 25.

*Oxygyrus keraudreni* Mc. Andr. – Oberwimmer, 1898: p. 588, figs 3-7 (non MacAndrew).

*Oxygyrus Keraudreni* Lesueur – Issel, 1911: p. 2.

*Oxygyrus Rangii* (Souleyet) – Issel, 1911: p. 2, fig. 11.

*Oxygyrus inflatus* Benson – Thiele, 1929, p. 257.

*Oxygyrus inflatus* Benson – Wenz, 1941: p. 1015.

*Oxygyrus keraudrenii* Rang – Wenz, 1941: p. 1016, figs 2915, 2916 (copied from Woodward, 1890 and Oberwimmer, 1898, respectively) (non *A. keraudrenii* Lesueur).

*Oxygyrus keraudrenii* Rang – van Straaten, 1966: p. 431 (non *A. keraudrenii* Lesueur).

*Oxygyrus keraudrenii* (Lesueur) – Richter, 1968: p. 363, fig. 15 (non Lesueur).

*Oxygyrus keraudreni* (Lesueur) – Di Geronimo, 1970: p. 50, pl. 2, fig. 3a, b (non Lesueur).

*Oxygyrus* sp. – Colantoni et al., 1970: pl. 26, fig. 8.

*Oxygyrus keraudreni* (Lesueur) – Vatova, 1974: p. 100 (non Lesueur).

*Oxygyrus keraudreni* (Lesueur, 1817) – van der Spoel, 1976: p. 137, fig. 133a-d (with extensive synonymy) (non Lesueur).

*Oxygirus [sic] keraudrenii* (Rang 1828), bellerophina stage – Nordsieck, 1973: p. 4, fig. 12.

*Oxygyrus keraudreni* (Lesueur, 1817) – Grecchi, 1984: p. 19, pl. 1, figs 15, 16 (non Lesueur).

*Oxygyrus keraudreni* (Lesueur, 1817) – Grecchi & Bertolotti, 1988: p. 118, pl. 2, fig. 15.

*Oxygyrus keraudreni* (Lesueur, 1817) – Seapy, 1990: p. 111, fig. 3E-H (non Lesueur).

*Oxygyrus keraudreni* (Lesueur, 1817) – Richter & Seapy, 1999: p. 633, fig. 5B (non Lesueur).

*Oxygyrus keraudrenii* (Lesueur, 1817) – Gofas et al., 2001: p. 192 (non Lesueur).

*Oxygyrus keraudrenii* (Lesueur, 1817) – Giovine, in Stoch, 2003, Faunaitalia website.

*Oxygyrus keraudreni* (Lesueur, 1817) – Janssen, 2007a: p. 149 (non Lesueur).

*Oxygyrus keraudreni* (Lesueur, 1817) – Janssen, 2007b: p. 51, pl. 1, figs 2, 3; pl. 16, figs 2-4 (non Lesueur).

*Oxygyrus keraudrenii* (Lesueur, 1817) – Rosenberg, 2009, Malacolog website (non Lesueur).

*Oxygyrus keraudreni* Benson 1835 [sic] – Seapy, 2010b, Tree of Life website.

*Oxygyrus keraudrenii* (Lesueur, 1817) – WoRMS website, 2011.

*Oxygyrus keraudrenii* (Lesueur 1817) – CLEMAM website, 2011.

## Description

See Seapy (1990, 2010b). The protoconch of this species is completely hidden in specimens higher than c. 0.3-0.4 mm and was illustrated only once (Richter, 1968: p. 365, fig. 15), but very juvenile specimens still showing the larval shell were found several times in the present ma-



terial (Figs 42G, H, 43A, B). Their nucleus is densely granulated (Fig. 42H). Such small specimens of this species retain their reddish-brown colour, already mentioned by Richter (1968), even in bottom samples.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 513/many; Me25-12 Kg2, SMF 332873/1; Me25-13 Kg1, SMF 332884/1; Me25-13 Kg2, SMF 332900/12; Me25-15 Kg1, SMF 332919/4; Me25-15 Kg2, SMF 332938/3; Me25-15 Ku, SMF 332958/7; Me25-16 Kg1, SMF 332974/14; Me25-16 Kg2, SMF 332997/4; Me25-17 Kg1, RGM 569 495/10, SMF 333024/27; Me25-17 Kg2, SMF 333046/7; Me25-18 Kg1, SMF 333064/10; Me25-18 Kg2, SMF 333078/15; Me25-19 Kg1, SMF 333094/3; Me25-19 Kg2, SMF 333113/1; Me25-20 Kg1, SMF 333133/9; Me25-20 Kg2, SMF 333152/1; Me25-20 Ku, SMF 333172/9; Me25-21 Kg1, SMF 333193/10; Me25-22 Kg2, SMF 333232/6; Me25-23 Kg1, SMF 333255/21; Me25-23 Kg2, SMF 333275/10; Me25-23 Ku, SMF 333293/7; Me25-24 Kg1, SMF 333310/9; Me25-24 Kg2, SMF 333326/12; Me25-37 Kg1, RGM 541 612/14, RGM 541 612a (Fig. 42E), RGM 541 612b/1 (Fig. 42F); Me25-37 Ku, SMF 333355/31; Me25-38 Ku, SMF 333390/2; Me25-39 Kg1, SMF 333405/1; Me25-39 Kg2, SMF 333423/2.

Gravity core T87/2/20G (Eemian), sample 2.59-2.60 m, RGM 569 091b/1; 2.47-2.48 m, RGM 569 094; 2.42-2.43 m, RGM 569 102/1; 2.36-2.37 m, RGM 569 122/3; 2.33-2.34 m, RGM 569 148/1, RGM 569 148a/1 (Fig. 42G-H); 2.30-2.31 m, RGM 569 181c/1; 2.24-2.25 m, RGM 569 184/2; 2.21-2.22 m, RGM 569 225a/1; 2.03-2.04 m, RGM 569 272/1, RGM 569 272a/1 (Fig. 43A, B).

Bologna samples: CJ 72 III-21 (bottom), RGM 570 745/11 juveniles; CJ 72 III-25 (top), RGM 570 526/3; CJ 72 III-27 (centre), RGM 570 686/1 protoconch; CR 20, RGM 570 382/1, 1 fragment; CR 31, RGM 570 463/2; CR 33, MZB (ex RGM 569 783)/4 juveniles; CR 34, RGM 570 664/1 juvenile; CR 39, RGM 570 606/25; CR 42, RGM 570 350/16; CR 68, RGM 570 713/30; CR 70, RGM 570 554/1, 3 juveniles; J 74-9, RGM 570 490/2, 25 juveniles; J 74-10, RGM 569 906/1; J 74-12, RGM 569 813/5 juveniles; T74-55-6, RGM 570 912/1 juvenile; T74-65-1, RGM 570 941/c. 40 (mainly juveniles); T74-65-2, RGM 570 880/13 juveniles.

## Discussion

D'Orbigny (1835: p. 169, footnote 1) was the first to raise doubts about the question if it really was Lesueur (1817c: p. 391) who described what at that time, and even until the present day, was and is understood under the name of *Atlanta keraudrenii* (nowadays generally included in the genus *Oxygyrus*), or if Lesueur's description rather represents a variety or juvenile specimen of *Atlanta peronii* Lesueur, 1817, introduced in the same paper, or even one of the other *Atlanta* species. Indeed, although the animal's soft parts and behaviour are described in some detail, Lesueur's description

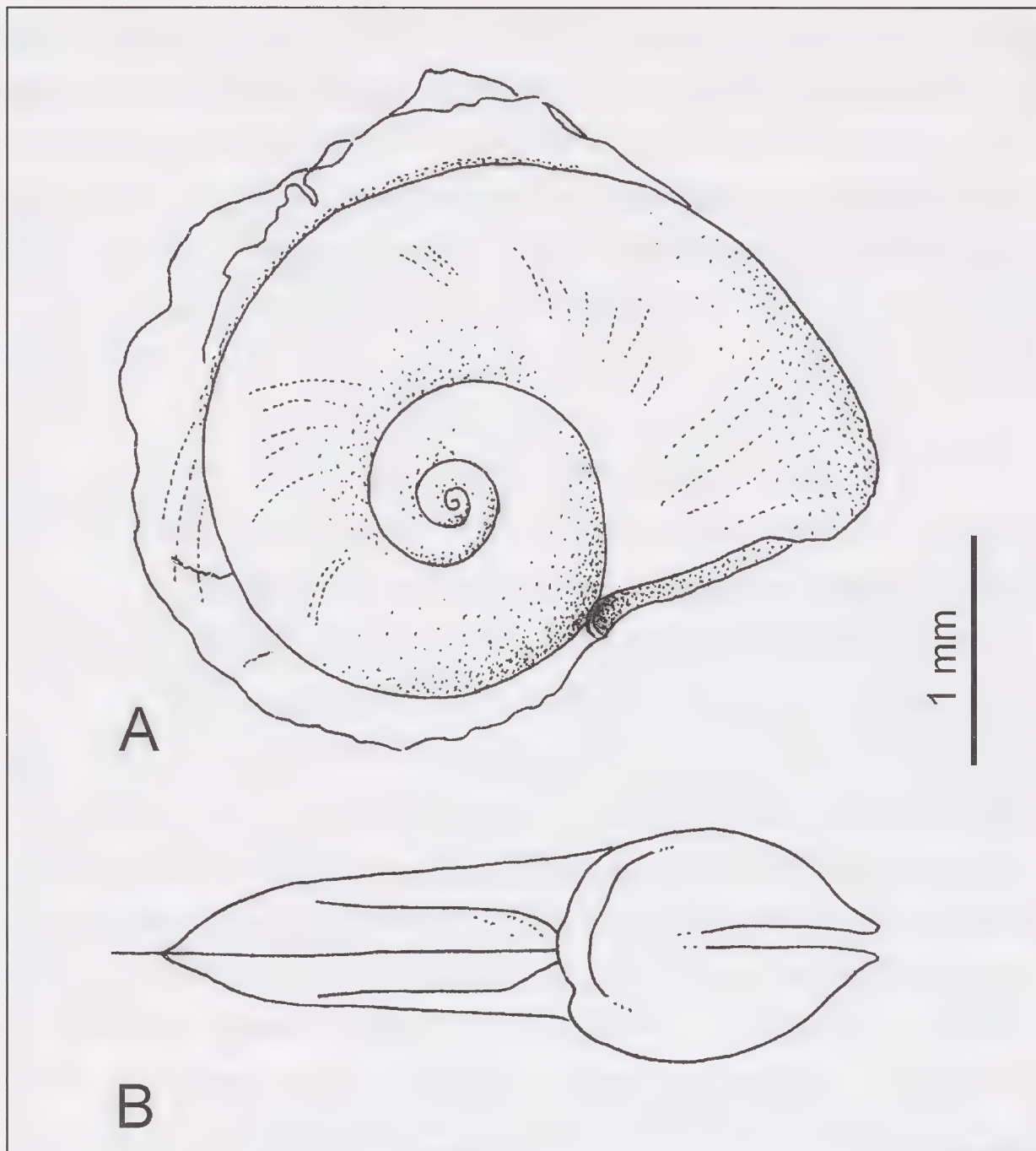
gives only little information about the shell. Comparing it with *A. peronii*, described one page earlier, Lesueur only wrote '*La spire est soudée sur elle-même, et non séparée par la carène ...*' [the spire is attached to itself, and not separated by the keel] which does not at all agree with what nowadays is indicated as *Oxygyrus keraudrenii* (as in that species, sure enough, the spire is completely concealed), but convincingly indicates a real *Atlanta* species. Furthermore, nothing was said by Lesueur about the quite remarkable fact that the shell is partly cartilagenous, or that the calcareous early whorls are clearly ornamented, which are striking features of *Oxygyrus*, not to be overlooked. D'Orbigny (1835: p. 171, footnote 1) noted this too, saying '*Lesueur était trop bon observateur pour ne pas dire que son espèce était cartilagineuse et non crétacée, ...*' [Lesueur was too good an observer not to say that his species was cartilagenous and not calcareous]. D'Orbigny points to the paper of Rang (1827: p. 380, but erroneously interpreting Lesueur's taxon) in which the name '*Atlanta Keraudrenii*' is used for what was at his time and still nowadays is understood under that name. However, d'Orbigny, respectfully, keeps the name *A. keraudrenii* Lesueur: '*.... afin de ne pas multiplier les dénominations et de ne pas surcharger la synonymie des espèces de ce genre*' [...to prevent multiplication of names and overload the synonymy of the species of this genus]. Also on the plate (d'Orbigny, 1834: pl. 11, figs 16-23) he illustrated this species with the name and authorship of Lesueur.

Similarly, Souleyet (1852: p. 367), agreeing with d'Orbigny, made a comparable remark on Lesueur's description and concluded that it was Rang (1827) who '*... le premier, a observé et décrit l'Atlante désignée aujourd'hui sous le nom d'Atlante de Keraudren ....*' [who was the first to observe and describe the *Atlanta* nowadays indicated with the name of *Atlante de Keraudren ....*], but also Souleyet (p. 364), politely, maintains the name and authorship of Lesueur, and this is continued by 'all authors' until the present day.

With both d'Orbigny and Souleyet I agree that what Lesueur described as *Atlanta Keraudrenii* represents a genuine *Atlanta* species and not what nowadays is understood under the name of *Oxygyrus keraudrenii*. Whether or not *A. keraudrenii* is a synonym of *A. peronii* is impossible to decide from the original publication with certainty. Considering the concise description, the absence of illustration and the fact that the various species in the genus *Atlanta* resemble each other closely, would leave no other solution than to interpret the taxon *Atlanta keraudrenii* Lesueur, 1817 as a nomen dubium, with no other possibility than to indicate it as '*Atlanta* sp.'. Judging from the concise description and measurement, however, it could very well be a juvenile *A. peronii*.

I consider it a case of 'exceptional need' (ICZN, 1999, art. 75.3) to clarify the taxonomic status of *Atlanta Keraudrenii*. To prevent future erroneous application of that name (ICZN, 1999, art. 75.3.1) I herewith designate as neotype a specimen of about the same size of '*une ligne et demie*' = c. 3.4 mm (Wikipedia, 2010). As type locality





**Fig. 4. A, B.** *Atlanta peronii* Rang, 1817, juvenile. Neotype of '*Atlanta Keraudrenii*' Rang, 1817. "Tydeman" Selvagens-Canary Islands Expedition 1980, CANCAP-IV, Sta. 4.062, Canary Islands, SE of Lanzarote; 28°48' N 13°43' W, bottom sample, sea-depth 820 m; 19-v-1980., coll. RMNH 112446. **A.** Apical view. **B.** Apertural view.

**Fig. 4. A, B.** *Atlanta peronii* Rang, 1817, esemplare juvenile. Neotipo di '*Atlanta Keraudrenii*' Rang, 1817. Campagna "Tydeman" Selvagens-Canary Islands 1980, CANCAP-IV, stazione 4.062, Isole Canarie, a sud-est di Lanzarote; 28°48' N 13°43' O, campione di fondo, profondità 820 m; 19-v-1980., coll. RMNH 112446. **A.** Vista apicale. **B.** Vista aperturale.

Lesueur gave 'la latitude de 19° 45' et la longitude de 32° 42', in which the 'latitude' could be North as well as South, the 'longitude' can only be West, which leads to 'Atlantic Ocean' as type locality. (ICZN, 1999, art. 75.3.6). For neotype locality and further data see **Fig. 4**. Although in van der Spoel's (1976: p. 167) 'Name index to the Heteropoda' the name *Atlanta keraudrenii* is also given as a synonym for *Atlanta peronii* (nr. 227 of the list on p. 21 in van der Spoel, 1976), this synonymy is not reflected in his listing of synonyms for '*A. peroni*' on p. 141. In this context it is remarkable that the same author (van der Spoel, 1976: p. 207) recorded the existence of two syntypes of *Atlanta keraudrenii* in MNHN (referred to as 'in the Eydoux & Souleyet collection'). It seems highly unlikely, however, that Lesueur's 1817c specimen(s?) ended up in the Eydoux & Souleyet collection some 30 years after their publication. Mrs Virginie Héros (MNHN) on my request searched in the Paris collections and indeed did not locate any syntypes under the name of *Atlanta keraudrenii*, nor are such specimens preserved among the *A. peronii* lecto- and paralectotype samples (ICZN 75.3.4). Therefore van der Spoel's statement must be considered erroneous. Additionally, van der Spoel's (1976: p. 137) quotation of Lesueur's description of *Atlanta keraudrenii* (as 'Lesueur, 1817a: 391, pl. 2') also is erroneous: the species was not illustrated by Lesueur. Rang's (1827) erroneous identification was accepted, mainly on the basis of d'Orbigny's and Souleyet's points of view, by practically all later authors. Few other au-

thors recognized the actual situation and referred to the species under the authorship of Rang (Wenz, 1941; van Straaten, 1966). It was Benson (1835: p. 176) who not only introduced the genus *Oxygyrus*, but also named the species, on which he based that name, as *O. inflatus*, giving ample information about the shell, the animals' soft parts and even its behaviour, but without an illustration. Curiously, Tesch (1906: p. 5), although with no comment accepting the genus *Oxygyrus*, just referred to *O. inflatus* with the latin diagnosis ('*Testa tumida, anfractibus transverse confertim striolatis; suturis profunde excavatis*') given by Benson, and added (in German) 'Nothing else is known about this species. An illustration does not exist', thereby disregarding the two and a half pages of description that preceded Benson's naming of the species. In 1908 Tesch (p. 5) included the name *Oxygyrus inflatus* with a query in the synonymy of '*O. keraudrenii*', without further discussion.

Both Thiele (1929: p. 257) and Wenz (1941: p. 1015) mentioned *Oxygyrus inflatus* Benson as the type species of *Oxygyrus*. Wenz, however, gave two illustrations with the name *O. keraudrenii*, copied from Woodward (1854, 1890) and Oberwimmer (1898), but he gave Rang as the author of the species, not Lesueur. Van der Spoel (1976: p. 138) referred to *O. inflatus* only as being mentioned by Tesch, 1906. Rosenberg (2009) and the CLEAM website list *Oxygyrus inflatus* Benson, 1835 as a synonym of *O. keraudrenii*.

In gravity core T87/2/20G this species was only found in the Eemian part of the section, which points to a preference for somewhat warmer water. In the box core and beam trawl samples *Oxygyrus inflatus* was found in many samples, sometimes in relatively large numbers and the same is true for the Bologna samples. Usually, however, this concerns juvenile specimens and only very rarely this species is preserved as internal moulds. Three specimens, dredged alive on 25 February 1992 in the Strait of Messina are in coll. RGM 458 946 (leg. A. Villari, don. June 1994).

#### Genus *Protatlanta* Tesch, 1908

Type species – "*Atlanta lamanoni*" of Souleyet, which name has been altered by E.A. Smith in '*Atlanta souleyeti*' (by original designation) = *Protatlanta souleyeti* (Smith, 1888) (Recent).

#### *Protatlanta souleyeti* (Smith, 1888) (Figs 3, 43C-H)

non Corne d'ammon – Lamanon, 1797: p. 134, pl. 63, figs 1-4 (= *Atlanta peronii*).

non *Steira lamanoni*, Eschscholtz, 1825: p. 735, fig. 3 (= *Atlanta peronii*).

Atlante de Lamanon – Eydoux & Souleyet, [1841]: pl. 18, figs 30-37.

Atalante de Lamanon – M.E. Gray, 1850: p. 46, pl. 240, fig. 3 (copied from Eydoux & Souleyet, fig. 30).

*Atlanta Lamanoni*, Eydoux – J.E. Gray, 1850: p. 101.

*Atlanta Lamanonii*, Souleyet, 1852: p. 371.

*Atlanta souleyeti* Smith, 1888: p. 43.



*Protatlanta souleyeti* (Smith) – Tesch, 1908: p. 9, pl. 1-2, figs 1-6.

*Protatlanta sculpta* Issel, 1911: p. 3, pl. 2, figs 1-5.

*Protatlanta sculpta* R. Issel var. *mediterranea* nov. var., Issel, 1915: p. 7, figs 2-4.

*Protoatlanta souleyeti* (E.A. Smith) – Wenz, 1941: p. 1015, fig. 2912 (copied from M.E. Gray, 1850).

*Protatlanta souleyetii* [sic] (E.A. Smith 1888) – Richter, 1968: p. 360, figs 12, 14 right (shell), 13 (operculum).

*Protatlanta mediterranea* Issel – Di Geronimo, 1970: p. 52, pl. 1, fig. 1a, b.

*Protatlanta mediterranea* Issel – Vatova, 1974: p. 100.

*Protatlanta souleyeti* Smith, 1888 [sic] – van der Spoel, 1976: p. 139, fig. 134a, b (copied from Tesch), c, d (with extensive synonymy).

*Protatlanta souleyeti* (Smith, 1888) – Grecchi & Bertolotti, 1988: p. 119, pl. 2, figs 11, 12.

*Protatlanta souleyeti* (Smith, 1888) – Seapy, 1990: p. 114, 1A, 45A-D, 5A.

*Protatlanta souleyeti* (Smith, 1888) – Richter & Seapy, 1999: p. 633, fig. 5A.

*Protatlanta souleyeti* (Smith E.A., 1888) – Gofas et al., 2001: p. 192.

*Protatlanta souleyeti* (Smith, 1888) – Janssen, 2007b: p. 54, pl. 17, fig. 4; pl. 18, figs 1, 2.

*Protatlanta souleyeti* (Smith 1888) – Seapy, 2008b, in Tree of Life website, 7 figs.

*Protatlanta souleyeti* (E.A. Smith, 1888) – Rosenberg, 2009, Malacolog website.

*Protatlanta souleyeti* (Smith E.A., 1888) – WoRMS website, m2011.

*Protatlanta souleyeti* (Smith E.A. 1888) – CLEMAM website, 2011.

## Description

See Richter (1968) and Seapy (1990, 2008b).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 514/many, RGM 569 515; 19 juveniles; Me25-13 Kg1, SMF 332885/4; Me25-13 Kg2, SMF 332901/7; Me25-15 Kg1, SMF 332920/29; Me25-15 Kg2, SMF 332939/9; Me25-15 Ku, SMF 332959/6; Me25-16 Kg1, SMF 332975/73; Me25-16 Kg2, SMF 332998/14; Me25-17 Kg1, RGM 569 496/15, SMF 333025/45; Me25-17 Kg2, SMF 333047/28; Me25-18 Kg1, SMF 333065/41; Me25-18 Kg2, SMF 333079/28; Me25-19 Kg1, SMF 333095/19; Me25-19 Kg2, SMF 333114/26; Me25-20 Kg1, SMF 333134/33; Me25-20 Kg2, SMF 333153/13; Me25-20 Ku, SMF 333173/56; Me25-21 Kg1, SMF 333194/98; Me25-21 Kg2, SMF 333214/6; Me25-22 Kg2, SMF 333233/10; Me25-23 Kg1, SMF 333256/44; Me25-23 Kg2, SMF 333276/35; Me25-23 Ku, SMF 333294/9; Me25-24 Kg1, SMF 333311/2; Me25-24 Kg2, SMF 333327/8; Me25-37 Kg1, RGM 541 613/70, RGM 541 613a/1 (**Fig. 43H**); Me25-37 Ku, SMF 333356/48; Me25-38 Kg1, SMF 333374/11; Me25-38 Ku, SMF 333391/1; Me25-39 Kg1, SMF 333406/4; Me25-39 Kg2, SMF 333424/9.

Gravity core T87/2/20G (Eemian), sample 2.36-2.37 m, RGM 569 123/20; 2.33-2.34 m, RGM 569 149/27; 2.30-2.31 m, RGM 569 166/14; 2.24-2.25 m, RGM 569 185/10; 2.21-2.22 m, RGM 569 205/7, RGM 569 205a/1 (**Fig. 43F**); 2.18-2.19 m, RGM 569 242b/8; 2.16-2.17 m, RGM 569 254c/5; 1.97-1.98 m, RGM 569 292b/1; 1.91-1.92 m, RGM 569 293/10; 1.91-1.92 m, RGM 569 300; 1.72-1.73 m, RGM 569 305b/3.

Gravity core T87/2/20G (Weichselian), sample 0.25-0.26 m, RGM 569 357/21, RGM 569 357a/1 (**Fig. 43G**).

Gravity core T87/2/20G (Holocene), sample 0.22-0.23 m, RGM 569 366b/6; 0.20-0.21 m, RGM 569 367b/5; 0.19-0.20 m, RGM 569 368b/1; 0.18-0.19 m, RGM 569 369b/1; 0.17-0.18 m, RGM 569 373b/4; 0.16-0.17 m, RGM 569 374b/1; 0.14-0.15 m, RGM 569 375b/2; 0.12-0.13 m, RGM 569 383b/9; 0.11-0.12 m, RGM 569 389b/5; 0.05-0.06 m, RGM 569 393/11.

Bologna samples: CJ 72 III-21, RGM 570 445/1; CJ 72 III-21 (bottom), RGM 570 744/1, many juveniles; CJ 72 III-25 (top), RGM 570 527/30; CJ 72 III-27 (centre), RGM 570 687/27 juveniles; CR 20, RGM 570 383/25; CR 31, RGM 570 462/8; CR 33, MZB (ex RGM 569 784)/20 juveniles; CR 34, RGM 570 665/6, many juveniles; CR 39, RGM 570 607/many; CR 42, RGM 570 351/many; CR 68, RGM 570 714/many; CR 70, RGM 570 555/16 juveniles; J 74-9, RGM 570 489/many juveniles, RGM 570 489a/1 (**Fig. 3**); J 74-10, RGM 569 905/4 protoconchs; J 74-12, RGM 569 814/1, 15 juveniles; T74-55-6, RGM 570 913/16 juveniles; T74-65-2, RGM 570 881/35 juveniles.

## Discussion

The taxon *Steira lamanoni* Eschscholtz (1825, fig. 3) is usually considered to be a *nomen dubium*, as its illustration is not sufficiently detailed to recognize the species or even the genus, it might just as well represent a species of *Atlanta* or of *Protatlanta*. Van der Spoel (1976: p. 167-168), however, in his 'Name index to the Heteropoda', listed both the genus *Steira* and the species *S. lamanoni*, referring to number 225 of his 'Systematic index to the Heteropoda', which is *Protatlanta souleyeti*. The name of *S. lamanoni*, however, is not listed under the synonyms of that species on p. 138-139.

Eschscholtz (1825: p. 735), when introducing the taxon *Steira lamanoni*, referred to the paper of Lamanon (1797), naming his new species after that author. But what Lamanon described (1797: p. 134) cannot be *Protatlanta souleyeti*. He depicted what we now call 'the keel' as '... le dos est armé d'une crête plate, unie, fragile, mince comme du papier, et formant tout autour comme une auréole solide: elle a près d'une demie-ligne de largeur; elle se prolongue sur les dos des spires, sert à les joindre les unes aux autres, et tient lieu de columelle', which I interpret as a not bad description of a calcareous keel inserting between the last whorls and that is demonstrated by Lamanon's illustrations as well, which clearly represent a specimen of *Atlanta*. In *Protatlanta* the keel is cartilagenous, and does not insert between the last and forelast whorl. As Eschscholtz included Lamanon's specimen in his new taxon it is a syntype.



To end the uncertainty in this matter I herewith designate Lamanon's figures 1-4, all representing the same specimen, as lectotype of *Steira lamanoni* Eschscholtz, 1825 and I consider it a junior synonym of *Atlanta peronii* Lesueur, 1817. I reproduce Lamanon's illustrations here as Fig. 5.

The species name *Protatlanta souleyeti* was introduced by Smith (1888: p. 43, as *Atlanta souleyeti*), stating: 'Eschscholtz employed the specific name *lamanonii* in 1825, and although I am inclined to consider that species beyond recognition, still I think that to prevent confusion another name should be given to the present species. I therefore propose to designate it *Atlanta souleyeti*'. Smith included the name *Steira lamanoni* Eschscholtz separately in his paper under the heading 'Undefined Species', stating '... beyond doubt representing an *Atlanta* ...'. This makes the taxon *Atlanta lamanoni*, as introduced by J.E. Gray (1850) to a secondary homonym and Smith was correct in replacing it.

In gravity core T87/2/20G (Tab. 3a, b) this species is found in the middle and later part of the Eemian and in the Holocene part of the section, distinctly pointing to a preference of warmer water.

Family Pterotracheoidae Rafinesque, 1814

Genus *Fioloida* Lesueur, 1817

Type species – "La F. de Desmarest. *F. desmarestiana*. Lesueur" = *Fioloida desmarestia* Lesueur, 1817 (by subsequent designation, de Blainville, 1825: p. 492).

*Fioloida desmarestia* Lesueur, 1817  
(Fig. 44A-C)

*F[ioloida] Desmarestia [sic]*, Lesueur, 1817b: p. 39, pl. 2, fig. 1a, b.

*F[ioloida] desmarestia* – Lesueur, 1817c: p. 160.

*Fioloida Lesueuri*, Eydoux et Souleyet – Vérany, 1853: p. 381.

*Fioloida Desmaresti* Lesueur – Issel, 1911: p. 9, fig. 3.

*Fioloida desmaresti* Lesueur, 1817 – van der Spoel, 1976: p. 164, figs 166.

*Fioloida desmaresti* Lesueur – Thiriot-Quiévreux, 1972: p. 560, pl. 6, figs A-F.

*Cyclostrema solutum* Di Geronimo, 1974b: p. 148, pl. 1, figs 2-6.

*Cyclostrema solutum* Di Geronimo, 1974 – Grecchi, 1984: p. 21, pl. 2, figs 16, 17.

*Fioloida desmaresti*, Lesueur 1817 – Nofroni, 1984: p. 23, 1 fig.

*Fioloida desmaresti* Lesueur, 1817 – Grecchi & Bertolotti, 1988: p. 124, pl. 2, figs 6, 7.

*Fioloida desmaresti* Lesueur, 1817 – Richter & Seapy, 1999: p. 643, fig. 12A (animal).

*Fioloida desmarestia* Lesueur, 1817 – Gofas et al., 2001: p. 192.

*Fioloida demarestia* Lesueur, 1817 – Janssen, 2007a: p. 149, pl. 13, figs 4-6; pl. 14, figs 1, 2.

*Fioloida demarestia* Lesueur 1817 – Seapy, 2008a, Tree of Life website, 10 figs.

*Fioloida desmarestia* Lesueur, 1817 – Rosenberg, 2009, Malacolog website.

*Fioloida desmarestia* Lesueur, 1817 – WoRMS website, 2011.

*Fioloida desmarestia* Lesueur 1817 – CLEMAM website, 2011.

## Description

See Thiriot-Quiévreux (1972), Di Geronimo (1974b), Janssen (2007a), Seapy (2008a).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Kú, RGM 569 517/16; Me25-11 Kg1, SMF 332863/1; Me25-17 Kg1, SMF 333026/3; Me25-21 Kg1, SMF 333195/1; Me25-37 Kg1, RGM 541 615/1.

Gravity core T87/2/20G, sample 2.59-2.60 m, RGM 569 091c/1; 2.42-2.43 m, RGM 569 119b/2; 2.16-2.17 m, RGM 569 254e/2; 1.97-1.98 m, RGM 569 292d/1 (Eemian).

Gravity core T87/2/20G, sample 1.43-1.44 m, RGM 569 332b/2; 1.08-1.09 m, RGM 569 336b/1 (Weichselian).

Gravity core T87/2/20G, sample 0.17-0.18 m, RGM 569 370/2; 0.16-0.17 m, RGM 569 374c/2; 0.14-0.15 m, RGM 569 375c/2; 0.12-0.13 m, RGM 569 377/6; 0.11-0.12, RGM 569 385/5; 0.095-0.105 m, RGM 569 390/3, RGM 569 390a, b /2 (Fig. 44A, B); 0.05-0.06 m, RGM 569 394/11, RGM 569 394a/1 (Fig. 44C) (Holocene).

Bologna samples: CJ 72 III-20, RGM 570 4406/many; CJ 72 III-21 (bottom), RGM 570 745/many; CJ 72 III-22,

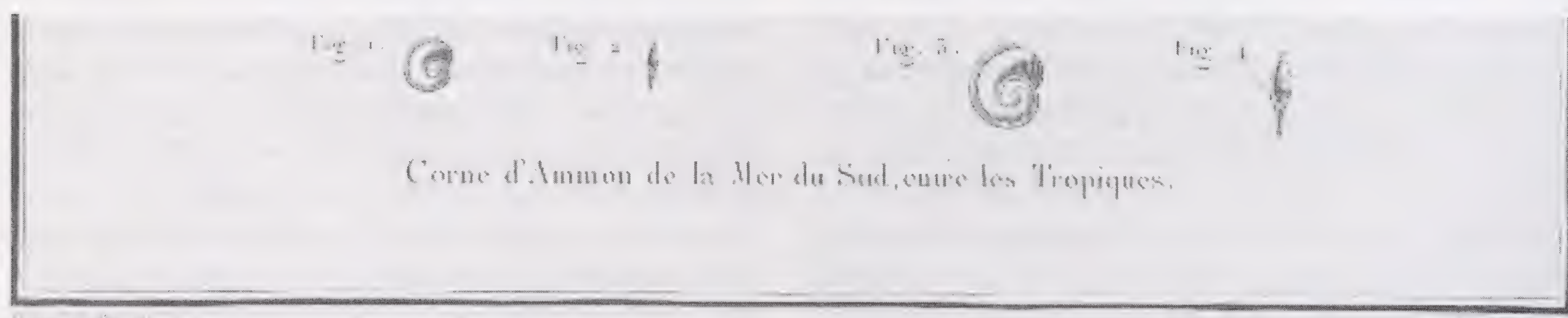


Fig. 5. *Atlanta peronii* Lesueur, 1817. Original illustrations of 'Corne d'Ammon' in Lamanon (1797: pl. 63, figs 1-4), lectotype of *Steira lamanoni* Eschscholtz, 1825.

Fig. 5. *Atlanta peronii* Lesueur, 1817. Illustrazione originale del 'Corne d'Ammon' in Lamanon (1797: tav. 63, figg. 1-4), lectotipo di *Steira lamanoni* Eschscholtz, 1825.



MZB (ex RGM 570 640)/many; CJ 72 III-25 (top), RGM 570 529/many; CJ 72 III-27 (centre), RGM 570 688/26; CR 20, RGM 570 385/28; CR 31, RGM 570 465/1; CR 33, MZB (ex RGM 569 785)/23; CR 34, RGM 570 666/many; CR 39, RGM 570 608/many; CR 42, RGM 570 352/many; CR 68, RGM 570 715/many; CR 70, RGM 570 562/many; J 74-9, RGM 570 491/many; J 74-12, RGM 569 816/many; J 74-19, RGM 570 481/1; T74-65-1, RGM 570 942/many (hundreds)); T74-65-2, RGM 570 883/many.

## Discussion

In my 2007a paper, on holoplanktonic molluscs from the Red Sea, I insisted on *Firoloida demarestia* being the correct spelling of the specific name of this species (based on ICZN 32.5). Rosenberg (2009), on the contrary, points to the paper of Lesueur (1817c) (which at the time was not yet available to me), published only few months after the 1817b paper, in which the name is spelled as *desmarestia* and with the vernacular name 'La Firoloïde de Desmarest'. Although the 1817c spelling is not emphasized as a correction of the 1817b spelling it makes clear that also in the first paper indeed the species was named after Desmarest. Therefore I agree that in this case ICZN art. 33.3.1 may be appropriate and consider the name *F. desmarestia* valid after all.

Tesch (1906), van der Spoel (1976) and Rosenberg (2009) gave numerous further spellings, spelling errors and synonyms of this species, the latter predominantly based on fully grown animals and not on the shell.

Because of their small size shells of *Firoloida desmarestia* are only rarely present in the box core and beam trawl samples. Also in gravity core T87/2/20G this species is very rare in the Eemian and Weichselian part of the section, but slightly more common during the later parts of the Holocene, with a maximum of 12 specimens in the uppermost sample (Tab. 3a). Especially in some of the Bologna samples from the Ionian and Tyrrhenian seas, however, larval shells of this species are very common, sometimes occurring in hundreds of specimens.

### Genus *Pterotrachea* Forskål, 1775

Type species – '*Pterot. coronata*' (by subsequent designation, J.E. Gray, 1847: p. 163) = *Pterotrachea coronata* Forskål, 1775 (Recent).

Note: Richter (1968), for the Mediterranean, and Richter & Seapy (1999: p. 645ff), for the South Atlantic, accepted four species in this genus, distinguished by differences in the soft parts of adult, shell-less specimens. These species are *Pterotrachea coronata* Forskål, 1775: *P. hippocampus* Philippi, 1836: *P. minuta* Bonnevie, 1920 and *P. scutata* Gegenbaur, 1855. Seapy (2000), however, demonstrated that *P. minuta* is a junior synonym of *P. hippocampus*, thus reducing the number of recognized Recent species to three.

Larval shells of these species have received only little attention, but two types of pterotracheid larval shells

were already described and illustrated by Krohn (1860), whose observations were acknowledged and extended by Richter (1968), who additionally found a third shelled *Pterotrachea* larva type. Both authors were not able to assign these larval specimens with certainty to the existing species. The forms indicated by Krohn (1860, fig. 2) as '*Pterotrachea* Sp. mit ebener Larvenschale' and '*Pterotrachea* Sp., mit quengerippter Larvenschale' are indicated by Richter (1968), respectively, as '*Pterotrachea*-Larve 1' and '*Pterotrachea*-Larve 2', which names were also used by Seapy (2008a) in the website 'Tree of Life' (3). The two forms are also found in the present material, some specimens of which are illustrated by Seapy (2008a). I have not been able, however, to isolate the third type, as distinguished by Richter, from samples studied for this paper.

Bandel & Hemleben (1987) mentioned a Jurassic *Pterotrachea* species and Janssen et al. (2011) recorded specimens strongly resembling *Pterotrachea* sp. 1 (see below) from the Eocene of Uzbekistan.

### *Pterotrachea* sp. 1 (Fig. 44D-F)

*Pterotrachea* 1te Sp./mit ebener Larvenschale – Krohn, 1860: p. 312, pl. 2, fig. 22.

*Pterotrachea*-Larve 1 (vermutlich *Pt. hippocampus*) – Richter, 1968: p. 373, fig. 19.

*Pterotrachea* sp. – Thiriot-Quiévreux, 1969: p. 355, pl. 4, fig. 5.

*Gleba cordata* Niebuhr, 1776 – Kunz, [1996]: p. 156, pl. 27, fig. 1 (non Niebuhr).

*Pterotrachea* larva 1 – Seapy, 2008a, Tree of Life website, 5 figs.

## Description

Shell very small, diameter *c.* 0.50 mm, consisting of 1¼ to 1½ almost planispiral whorls with a circular transverse section. The last ¼ -½ whorl separating from the initial whorl. Aperture circular without any reinforcement structures. Shell surface with faintly visible incremental lines, otherwise smooth.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 519/15.

Gravity core T87/2/20G (Eemian), 2.42-2.43 m, RGM 569 104/44, RGM 569 104a, b /2 (Fig. 44E, F); 2.36-2.37 m, RGM 569 124/34; 2.33-2.34 m, RGM 569 151/34; 2.30-2.31 m, RGM 569 167/26; 2.24-2.25 m, RGM 569 186/22, RGM 569 186a/1 (Fig. 44D); 2.21-2.22 m, RGM 569 206/21; 2.18-2.19 m, RGM 569 227/8; 2.16-2.17 m, RGM 569 254d/3; 1.97-1.98 m, RGM 569 292c/3; 1.91-1.92 m, RGM 569 294/3; 1.76-1.77 m, RGM 569 304b/1. Gravity core T87/2/20G (Weichselian), sample 1.33-1.34 m, RGM 569 333b/1; 1.08-1.09 m, RGM 569 336a/1; 0.25-0.26 m, RGM 569 365b/1.



Gravity core T87/2/20G (Holocene), sample 0.22-0.23 m, RGM 569 366c/2; 0.18-0.19 m, RGM 569 369c/1; 0.05-0.06 m, RGM 569 395/5.

Bologna samples: CJ 72 III-21 (bottom), RGM 570 746/1; CJ 72 III-22, RGM 570 641/1 juvenile; CJ 72 III-27 (centre), RGM 570 689/4 juveniles; CR 33, MZB (ex RGM 569 786)/7; CR 34, RGM 570 667/6; CR 39, RGM 570 609/24; CR 42, RGM 570 353/30; CR 68, RGM 570 716/12; CR 70, RGM 570 556/10; J 74-9, RGM 570 492/many; J 74-10, RGM 569 907/10; J 74-12, RGM 569 817/4; T74-65-1, RGM 570 943/7; T74-65-2, RGM 570 882/9.

## Discussion

Richter (1968) presumed this larval shell to probably belong to *Pterotrachea hippocampus*. Shells of this type at first glance look quite similar to those of the pseudothecosomatous species *Gleba cordata* (see below) in which also the proximal part of the shell disconnects from the nucleus, but in a frontal view (Fig. 44F) it is clear that the shell of the present species is dextral, whereas that of *Gleba* is sinistral (Fig. 52A). Also the shapes of the nuclei are utterly different (compare Figs 44D, E and 52E).

From the range chart of core T87/2/20G (Tab. 3a, b) it is clear that this species is especially common in the middle part of the Eemian interval, with only few specimens occurring during the Weichselian and the Holocene. Also in some of the Bologna bottom samples the species is sometimes present in considerable numbers.

### *Pterotrachea* sp. 2 (Fig. 44G, H)

*Pterotrachea* 2te Sp. mit quengerippter Larvenschale – Krohn 1860: Op. 32, pl. 2, fig. 24.

*Firola* (*Pterotrachea*) *coronata* Forskål – Franc, 1948: p. 19, pl. 1, fig. 6, 7 (veliger).

*Pterotrachea*-Larve 2 (vermutlich *Pt. minuta*) – Richter, 1968: p. 373, fig. 20 (shell), 22 (veliger).

*Pterotrachea coronata* Forskål – Thiriot-Quévieux, 1969: p. 355, pl. 4, fig. 7.

*Pterotrachea* sp. 1 – Thiriot-Quévieux, 1973: p. 253, fig. 7B.

*Pterotrachea* larva 2 – Seapy, 2008a, Tree of Life website, 7 figs.

## Description

Shell very small, diameter c. 0.43 mm, consisting of 1¼ planispiral whorls with a rounded transverse section. The nucleus and the initial whorl are smooth, the remaining part of the body whorl is ornamented with regular transverse riblets and does not separate from the preceding whorl.

## Material examined

Gravity core T87/2/20G (Eemian), sample 2.42-2.43 m, RGM 569 105/3, 3 fragments, RGM 569 105a/1 (Fig. 44H); 2.36-2.37 m, RGM 569 125/10, 3 fragments, RGM

569 125a/1; 2.33-2.34 m, RGM 569 152/6, 1 fragment; 2.30-2.31 m, RGM 569 168/2, 2 fragments; 2.24-2.25 m, RGM 569 187/3, 1 fragment; 2.21-2.22 m, RGM 569 207/1, 2 fragments; 2.18-2.19 m, RGM 569 228/1, RGM 569 228a/1 (Fig. 44G); 1.97-1.98 m, RGM 569 285/1.

Bologna samples: CR 33, MZB (ex RGM 569 787)/1; J 74-9, RGM 570 594/11.

## Discussion

Franc (1948), as *Firola* (*Pterotrachea*) *coronata*, did not illustrate the larval shell, but only the animal in veliger state, basically agreeing with Richter's (1968, fig. 22) illustration, but in his description he clearly indicated the transversal ornament, which makes it clear that he observed specimens of the present species. He did not, however, explain his identification of the species.

The specimen caught alive, illustrated in Richter (1968, fig. 20) reaches a somewhat larger diameter (c. 0.67 mm) and has the last half whorl ornamented, and the same is true for the shell described by Thiriot-Quévieux (1969, 1973).

If indeed *Pterotrachea* sp. 1 is the larval shell of *P. hippocampus*, then *Pterotrachea* sp. 2 cannot be *P. minuta*, as suggested by Richter, as these taxa were found to be synonyms, but has to belong to either *P. coronata* or *P. scutata*. It is logical then to suppose that *Pterotrachea* sp. 3, as described by Richter (1968) and Thiriot-Quévieux (1973), vice versa, belongs to either *P. scutata* or *P. coronata*. This enigma can only be solved by observing the metamorphosis of larval specimens.

In core T87/2/20G (Tab. 3a, b) this species has a similar distribution, although generally less common, as *Pterotrachea* sp. 1. The species was found only in two of the Bologna bottom samples.

### Family Carinariidae de Blainville, 1818

#### Genus *Carinaria* Lamarck, 1801

Type species – *Carinaria vitrea* [= *Carinaria cristata* (Liné, 1767)] (by monotypy) (Recent).

### *Carinaria lamarckii* de Blainville, 1817 (Fig. 45A-G)

Carinaire Lamarck – Péron & Lesueur, 1810: p. 69, pl. 2, fig. 15.

La Carinaire de Lamarck, C. *Lamarckii* [sic] Péron et Lesueur, de B[lainville], 1817: p. 107 (non Péron & Lesueur).

*Pterotrachea lophyra* delle Chiaje, 1822: pls 14-15.

*Pterotrachea lophira* delle Chiaje, 1822: pl. 41.

Carinaire de la Méditerranée, *Carinaria mediterranea* de Blainville: p. 283.

Carinaire vitrée – Costa, 1829: p. 107, 2 pls.

*Carinaria mediterranea*, Per. – Vérany, 1853: p. 381.

*Carinaria lamarckii*, Péron et Lesueur 1810 – Smith, 1888: p. 32 (with extensive synonymy).

*Carinaria mediterannea* [sic] Pér. et Les. – Oberwimmer, 1898: p. 586.



*Carinaria mediterranea* Lam. – van Straaten, 1966: p. 431.  
*Carinaria lamarcki* Péron & Lesueur 1810 – Richter, 1968: p. 366, fig. 16 (juvenile specimen), 17 (operculum).  
*Carinaria lamarcki* Péron & Lesueur – Di Geronimo, 1970: p. 63, pl. 2, fig. 4.  
*Carinaria* sp. – Colantoni et al., 1970: pl. 26, fig. 9.  
*Tubiola vatovai* n. sp., Nordsieck, 1973p. 4, fig. 5.  
*Carinaria lamarcki* Péron et Lesueur – Vatova, 1974. p. 104.  
*Carinaria lamarcki* Péron and Lesueur, 1810 – Thiriot-Quiévreux, 1975: p. 379ff, fig. 1a-d.  
*Carinaria lamarcki* Peron & Lesueur, 1810 – van der Spoel, 1976: p. 152, fig. 152a, 152c-h (non fig. 152b, c = *Heliconoides inflata*?) (with additional synonymy).  
*Carinaria lamarcki* Peron e Lesueur, 1810 – Grecchi & Bertolotti, 1988: p. 123, pl. 2, figs 16, 17.  
*Carinaria lamarcki* Péron and Lesueur 1810 – Seapy, 2008a Tree of Life website, 9 figs.  
*Carinaria lamarckii* Blainville, 1817 – Rosenberg, 2009, Malacolog website (with additional synonymy).  
*Carinaria lamarckii* Blainville, 1817 – WoRMS website, 2011.  
*Carinaria mediterranea* de Blainville 1824 – CLEMAM website, 2011.

## Description

See Thiriot-Quiévreux (1975) and Seapy (2008a).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 516/ 6, 11 protoconchs; Me25-13 Kg1, SMF 332886/1 protoconch; Me25-13 Kg2, SMF 332902/1 protoconch; Me25-15 Kg1, SMF 332921/5, 2 protoconchs; Me25-15 Kg2, SMF 332940/12; Me25-15 Ku, SMF 332960/2, 1 protoconch; Me25-16 Kg1, SMF 332976/3, 9 protoconchs; Me25-16 Kg2, SMF 332999/13, 1 protoconch; Me25-17 Kg1, RGM 569 498/3, 2 protoconchs, SMF 333027/7, 5 protoconchs; Me25-17 Kg2, SMF 333048/11, 3 protoconchs; Me25-18 Kg1, SMF 333066/1, 2 protoconchs; Me25-18 Kg2, SMF 333080/3, 4 protoconchs; Me25-19 Kg2, SMF 333115/4, 4 protoconchs; Me25-20 Kg1, SMF 333135/9, 1 protoconch; Me25-20 Kg2, SMF 333154/4, 4 protoconchs; Me25-20 Ku, SMF 333174/1, 3 protoconchs; Me25-21 Kg2, SMF 333215/6; Me25-22 Kg2, SMF 333234/4; Me25-23 Kg1, SMF 333257/10; Me25-23 Kg2, SMF 333277/3, 1 protoconch; Me25-23 Ku, SMF 333295/2; Me25-24 Kg2, SMF 333328/1; Me25-24 Ku, SMF 333342/3; Me25-37 Kg1, RGM 541 614/5, RGM 541 614a/1 (**Fig. 45A, B**); Me25-37 Ku, SMF 333357/11, 1 protoconch; Me25-38 Kg1, SMF 333375/2, 2 protoconchs; Me25-38 Ku, SMF 333392/6; Me25-39 Kg1, SMF 333407/3, 3 protoconchs; Me25-39 Kg2, SMF 333425/2; Me51/3-562, DCS RGA516/1 protoconch.

Gravity core T87/2/20G (Eemian), sample 2.73-2.74 m, RGM 569 086b/1; 2.42-2.43 m, RGM 569 103/8 protoconchs; 2.36-2.37 m, RGM 569 126/13 protoconchs, RGM 569 126a/1 protoconch (**Fig. 45C, D**); 2.33-2.34 m, RGM 569 159/9 protoconchs; 2.30-2.31 m, RGM 569

169/11 protoconchs; 2.24-2.25 m, RGM 569 188/11 protoconchs; 2.21-2.22 m, RGM 569 208/6 protoconchs; 2.18-2.19 m, RGM 569 242c/2 protoconchs; 2.16-2.17 m, RGM 569 243/11 protoconchs; 2.14-2.15 m, RGM 569 255/4 protoconchs; 2.09-2.10 m, RGM 569 267/5 protoconchs; 2.03-2.04 m, RGM 569 273/3 protoconchs; 1.91-1.92 m, RGM 569 300b/1 protoconch; 1.70-1.71 m, RGM 569 306/31 protoconchs; 1.68-1.69 m, RGM 569 314/40, RGM 569 314b, c/3 (**Fig. 45E-G**); 1.65-1.66 m, RGM 569 326b/8; 1.61-1.62 m, RGM 569 327b/3; 1.60-1.61 m, RGM 569 328b/1.

Gravity core T87/2/20G (Weichselian), sample 1.58-1.59 m, RGM 569 329b/1; 1.48-1.49 m, RGM 569 331b/1; 1.43-1.44 m, RGM 569 332c/1; 1.33-1.34 m, RGM 569 333c/3; 1.03-1.04 m, RGM 569 337b/2; 0.98-0.99 m, RGM 569 338a/1; 0.93-0.94 m, RGM 569 340b/5; 0.80-0.81 m, RGM 569 344b/2; 0.77-0.78 m, RGM 569 345b/2; 0.75-0.76 m, RGM 569 346b/8; 0.60-0.61 m, RGM 569 350b/2; 0.50-0.51 m, RGM 569 352b/1; 0.30-0.31 m, RGM 569 356b/2; 0.25-0.26 m, RGM 569 358/5.

Gravity core T87/2/20G (Holocene), sample 0.22-0.23 m, RGM 569 366d/4; 0.20-0.21 m, RGM 569 367c/3; 0.19-0.20 m, RGM 569 368c/2; 0.18-0.19 m, RGM 569 369d/5; 0.17-0.18 m, RGM 569 373c/4; 0.16-0.17 m, RGM 569 374d/5; 0.14-0.15 m, RGM 569 375d/13; 0.12-0.13 m, RGM 569 376/15; 0.11-0.12 m, RGM 569 384/6; 0.095-0.105 m, RGM 569 391b/1; 0.05-0.06 m, RGM 569 396/8.

Bologna samples: CJ 72 III-20, RGM 570 407/16 protoconchs; CJ 72 III-21, RGM 570 443/4, 1 protoconch, 2 fragments; CJ 72 III-21 (bottom), RGM 570 747/many protoconchs; CJ 72 III-22, MZB (ex RGM 570 642)/14 protoconchs; CJ 72 III-25 (top), RGM 570 528/42 protoconchs; CJ 72 III-27 (centre), RGM 570 690/many protoconchs; CR 20, RGM 570 384/c. 40 protoconchs; CR 31, RGM 570 464/11 protoconchs; CR 33, MZB (ex RGM 569 788)/17 protoconchs; CR 34, RGM 570 668/11 protoconchs; CR 39, RGM 570 610/many protoconchs; CR 42, RGM 570 354/c. 40 protoconchs; CR 68, RGM 570 717/many protoconchs; CR 70, RGM 570 557/many protoconchs; J 73-29, RGM 570 428/1 protoconch; J 74-9, RGM 570 493/1, many protoconchs, 3 fragments; J 74-10, RGM 569 908/2 protoconchs; J 74-12, RGM 569 815/35 protoconchs; T74-55-6, RGM 570 914/23 protoconchs; T74-65-1, RGM 570 944/many protoconchs; T74-65-2, RGM 570 884/c. 50 protoconchs; T74-65-9, RGM 570 930/2 protoconchs; T74-65-10, RGM 570 860/4 fragments.

## Discussion

Janssen (2007b: p. 57) stated that it was Watson (1898: p. 278) who first latinized Péron & Lesueur's 1810 vernacular name 'Carinaire Lamarck' to *Carinaria lamarcki*, but already in 1817 de Blainville applied a latin name for this species, viz. *Carinaria lamarkii* [sic] and therefore must be considered the author of this species. The spelling 'lamarkii' is an 'incorrect original spelling' in the sense of ICZN art. 35.5, and should be corrected, as de Blainville also used the vernacular name (after Péron &



Lesueur) 'La Carinaire de Lamarck'. Few years later the same author (de Blainville, 1824: p. 283) introduced another name, *Carinaria mediterranea*, for the same species, referring to the same illustration in Péron & Lesueur (1810).

In core T87/2/20G (Tab. 3a, b) protoconchs of this species are predominantly present during the Eemian and Holocene intervals, but the species occurs also, albeit in smaller numbers, during the Weichselian.

Richter (1968: p. 22) recorded this species as the most exceptional heteropod of the Tyrrhenian Sea. Also Vato (1974) considered this species to be 'non comune nel Mediterraneo' and found larval specimens to be rather rare in four bottom samples from the Ionian Sea. In many of the bottom samples analyzed for the present paper, inclusive these from the Ionian and Tyrrhenian seas, larval shells occur frequently, counting up to over a hundred specimens in several of the Bologna samples. Specimens beyond protoconch stage, however, are rare and were almost exclusively found in the box core and beam trawl samples.

Superfamily Epitonioidae Berry, 1910

Family Janthinidae Lamarck, 1822

Genus *Janthina* Röding, 1798

Type species – *Helix Janthina* (by subsequent designation, Herrmannsen, 1846: p. 551) = *Janthina janthina* (Linnaeus, 1758 (Recent)).

*Janthina globosa* (Swainson, 1822)  
(Fig. 6A, B)

*Janthina globosa*, Swainson, 1822: pl. 85 (middle two figs).

*Janthina prolongata* de Blainville, 1822: p. 155.

*Janthina prolongata* Blainville, 1822 – Laursen, 1953: p. 28, figs 30-35 (with additional synonyms).

*Janthina nitens* Menke, 1828 – Gofas et al., 2001: p. 186.

*Janthina nitens* Menke, 1828 – Giovine in Stoch, 2003, Faunaitaliana website.

*Janthina (Janthina) prolongata* de Blainville, 1822 – Janssen, 2007b: p. 59, pl. 1, figs 5, 6.

*Janthina globosa* Swainson, 1822 – Rosenberg, 2009, Malacolog website (with additional synonyms).

*Janthina prolongata* De Blainville, 1822 – ETI website, 2011, fig.

*Janthina prolongata* Blainville, 1822 – WoRMS website, 2011.

*Janthina prolongata* de Blainville 1822 – CLEMAM website, 2011.

## Description

See Laursen (1953).

## Material examined

Box core and beam trawl samples: Me25-15 Kg1, SMF 332922/1, 1 (Fig. 6); Me25-15 Ku, SMF 332961/2, 1?; Me25-16 Kg2, RGM 569 492/1; Me25-20 Kg1, SMF 333136/1; Me25-22 Kg2, SMF 333235/1; Me25-23 Kg1, SMF 333258/1 (all juveniles).

## Discussion

Initially, on the basis of Laursen (1953), I identified these immature specimens as *Janthina prolongata* de Blainville, 1822. Rosenberg (2009), however, found that *Janthina globosa* Swainson, 1822 was published a few months before de Blainville's paper and therefore has priority. The WoRMS and CLEMAM websites, however, still maintain the name *I. globosa* as a synonym or misidentification of *J. prolongata*.

Only few specimens were found in the box core and beamtrawl samples. The species was already recorded from the western Mediterranean Basin by Laursen (1953, fig. 34). It cannot be excluded that the few protoconchs found in the present material, and referred to under *J. janthina?*, below, might belong to this species as well.

*Janthina janthina?* (Linnaeus, 1758)  
(Figs 7A, B, 45H)

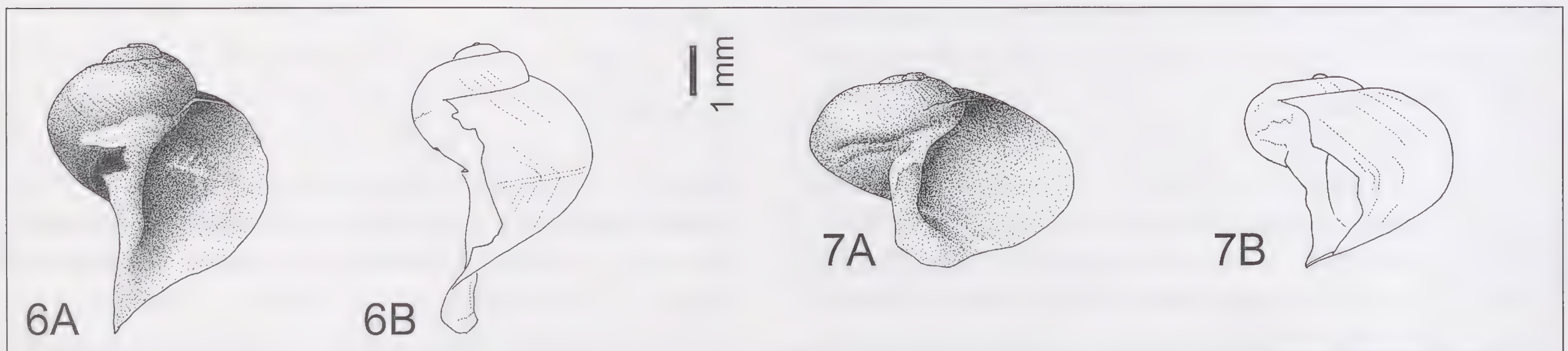
References for *Janthina janthina*:

*Helix janthina*, Linnaeus, 1758: p. 772.

*Janthina janthina* (Linné) 1758 – Laursen, 1953: p. 15, figs 10, 11, 14, 15 (shell), 16-18 (radula), 19 (distribution) (with extensive synonymy).

*Janthina janthina* Linné – Abbott, 1954: p. 160, pl. 4j.

*Janthina janthina* (Linné, 1758) – Gofas et al., 2001: p. 186.



**Fig. 6, 7.** *Janthina* spp. **Fig. 6A, B.** *Janthina globosa* (Swainson, 1822), juvenile; Ionian Sea, sample Me25-15 Kg1, SMF 332922. **Fig. 7A, B.** *Janthina janthina?* (Linnaeus, 1758), juvenile; same data, SMF 332941 juvenile. **A.** Apertural views. **B.** Lateral views.

**Fig. 6, 7.** *Janthina* spp. **Fig. 6A, B.** *Janthina globosa* (Swainson, 1822), esemplare juvenile; Mar Ionio, campione Me25-15 Kg1, SMF 332922. **Fig. 7A, B.** *Janthina janthina?* (Linnaeus, 1758), esemplare juvenile; stessi dati, SMF 332941 **A.** Viste aperturali. **B.** Viste laterali.



*Janthina janthina* (Linnaeus, 1758) – Rosenberg, 2009, Malacolog website (with additional synonymy).

*Janthina janthina* (Linnaeus, 1758) – WoRMS website, 2011.

*Janthina janthina* (Linné 1758) – CLEMAM website, 2011.

*Janthina janthina* (Linnaeus, 1758) – ETI website, 2011, 1 fig.

## Description

See Laursen (1953).

## Material examined

Box core and beam trawl samples: Me25-15 Kg1, SMF 332923/1; Me25-15 Kg2, SMF 332941/1, 1 (Fig. 7); Me25-16 Kg1, SMF 332977/2; Me25-16 Kg2, SMF 333000/2; Me25-17 Kg1, SMF 333028/3; Me25-18 Kg1, SMF 333067/1; Me25-18 Kg2, SMF 333081/1; Me25-19 Kg1, SMF 333096/1; Me25-21 Kg1, SMF 333196/1; Me25-21 Kg2, SMF 333216/1; Me25-22 Kg2, SMF 333236/1; Me25-23 Kg1, SMF 333259/4; Me25-23 Kg2, RGM 569 504/2, SMF 333278/5, 1 protoconch; Me25-23 Ku, SMF 333296/2; Me25-24 Kg1, SMF 333312/3; Me25-24 Kg2, SMF 333329/4; Me25-37 Kg1, RGM 541 616/1 (Fig. 45H); Me25-37 Ku, SMF 333358/5.

Bologna samples: CR 34, RGM 570 669/1 protoconch?; CR 68, RGM 570 718/4 protoconchs?; J 74-12, RGM 569 824/1 protoconch?; T74-65-1, RGM 570 945/2 protoconchs?; T74-65-2, RGM 570 885/2 protoconchs.

## Discussion

Robert Moolenbeek (ZMA) was kind enough to compare some specimens of the present material with *Janthinidae* in the collections of the Zoological Museum (Amsterdam). Results are not unambiguous, as the admittedly juvenile shells do not agree completely with any of the species discussed by Laursen (1953). They resemble most the *Janthina janthina*-complex in shape, but lack the ‘sharp, regular striae’ (Laursen, 1953: p. 18) on their early whorls. According to that author, however, these are not always present in this species. This gives me no other choice than including the specific name with a query.

The few protoconchs extracted from the Bologna samples could only be identified as *Janthina* sp. (Fig. 45H).

### *Janthina pallida* Thompson, 1840

Note: This species was recorded by Bucquoy et al. (1886) from the Mediterranean coast of France, and from the Strait of Messina by Berdar et al. (1982: p. 40). Also the ETI website (2011) mentions its occurrence in the Mediterranean. Most probably these are incidental immigrations from the Atlantic, restricted to the western part of the basin.

Clade Thecosomata de Blainville, 1824 (= ‘Pteropoda’)

Superfamily Limacinoidea J.E. Gray, 1847

(= Euthecosomata Meisenheimer, 1905, partim)

Family Limacinidae J.E. Gray, 1847

Genus *Heliconoides* d’Orbigny, 1835

Type species. – *Atlanta inflata* d’Orb. (by subsequent designation, Hermannsen, 1846: p. 514) = *Heliconoides inflata* (d’Orbigny, 1834 (Recent).

*Heliconoides inflata* (d’Orbigny, 1834)

(Fig. 46A, B)

*A[llanta] [sic] inflata* d’Orbigny, 1834: pl. 12, figs 16-19.

*Atlanta (Heliconoides) inflata* d’Orbigny, 1835: p. 174.

*Spirialis rostralis*, Eydoux et Souletet – Vérany, 185: p. 380.

*Embolus planorboides* Seguenza, 187, 5p. 148.

*Limacina inflata* Gray – Oberwimmer, 1898: p. 588 (non Gray).

*Limacina inflata* d’Orbigny – Steuer, 1911: p. 714, fig. 1.

*Limacina inflata* (Orb.) – van Straaten, 1966: p. 431.

*Limacina (Thilea) inflata* (Orbigny) – van der Spoel, 1967: p. 50, figs 17, 18 (with extensive synonymy of Recent occurrences).

*Spiratella inflata* (d’Orbigny) – Blanc-Vernet et al., 1969p. 220.

*Limacina inflata* (d’Orbigny) – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280ff, pl. 1, figs 11, 12.

*Spiratella inflata* (d’Orbigny) – Pastouret, 1970: p. 238, pl. 1, fig. 1.

*Limacina inflata* (d’Orbigny) – Di Geronimo, 1970: p. 66, pl. 4, fig. 2a-c.

*Spiratella inflata* (Orb.) – Colantoni et al., 1970: p. 177, pl. 24, fig. 7a-c.

*Limacina inflata* (d’Orbigny) – Herman, 1971a: p. 617-619, pl. 1, fig. 3.

*Limacina inflata* – Herman, 1971b: p. 475ff, pl. 1, figs 8-10.

*Spiratella inflata* (Orb.) – Froget & Pastouret, 1972: p. 612ff.

*Spiratella inflata* (d’Orbigny) – Vatova, 1974: p. 107.

*Spiratella inflata* Orbigny 1836 – Nordsieck, 1973: p. 6, fig. 21.

*Limacina inflata* (d’Orbigny, 1836) – Almogi-Labin & Reiss, 1977: p. 13, pl. 7, figs 3-9.

*Limacina inflata* (d’Orbigny) – Bé & Gilmer, 1977: p. 773, pl. 3, fig. 1a-d.

*Limacina inflata* – Herman, 1981: p. 190.

*Limacina inflata* (d’Orbigny, 1836) – Grecchi, 1984: p. 14, pl. 1, fig. 5.

*Limacina inflata* (d’Orbigny) – Buccheri, 1984: p. 80, pl. 1, fig. 3a-c.

*Limacina inflata* (d’Orbigny) – Buccheri & di Stefano, 1984: p. 182, pl. 1, figs 1-3.

*Limacina inflata* – Vergneau-Grazzini et al., 1988: p. 8, pl. 3, figs 19-21.

*Limacina inflata* (d’Orbigny, 1836) – Grecchi & Bertolotti, 1988: p. 101, pl. 1, fig. 1.

*Limacina inflata* (d’Orbigny, 1836) – Biekart, 1989: p. 207ff, pl. 1, fig. 5a, b.



*Limacina inflata* (d'Orbigny) – Janssen, 1990: p. 14, pl. 2, figs 5-7, pl. 3, fig. 11, pl. 10, fig. 2.  
*Limacina inflata* – Violanti et al., 1991: p. 24ff.  
*Limacina* (*Striolimacina*) [*sic*] *inflata* d'Orbigny, 1836 – Janssen, 1999: p. 5 (abstract).  
*Limacina* (*Heliconoides*) *inflata* (d'Orbigny – Janssen, 1999: p. 14, pl. 2, figs 10, 11.  
*Embolus planorboides* – Bertolaso & Palazzi, 2000: p. 31, figs 180-182.  
*Limacina inflata* (d'Orbigny, 1836) – Gofas et al., 2001: p. 200.  
*Heliconoides inflata* (d'Orbigny) – Janssen, 2004: p. 110, pl. 1, figs 4-6.  
*Limacina inflata* (d'Orbigny, 1834) – Rosenberg, 2009, Malacolog website.  
*Limacina inflata* (d'Orbigny, 1836) – WoRMS website, 2011.  
*Limacina inflata* (d'Orbigny 1836) – CLEMAM website, 2011.

## Description

See van der Spoel (1967), Janssen (1990, 2004). Rampal (2011: p. 370) refers distinctly to the forma A of this species (see below) when writing: '*tour très développé avec un rostre médian parfois orné d'une bande hyaline*'. She refers to this species as very common in the Mediterranean.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 520/many; Me25-11 Kg1, SMF 332864/21; Me25-12 Kg2, SMF 332874/2; Me25-13 Kg1, SMF 332887/4; Me25-13 Kg2, SMF 332903/24; Me25-13 Ku, SMF 332912/6; Me25-15 Kg1, SMF 332924/17; Me25-15 Kg2, SMF 332942/50; Me25-15 Ku, SMF 332962/89; Me25-16 Kg1, SMF 332978/157; Me25-16 Kg2, SMF 333001/65; Me25-17 Kg1, SMF 333029/33; Me25-17 Kg2, SMF 333049/71; Me25-18 Kg1, SMF 333068/24; Me25-18 Kg2, SMF 333082/26; Me25-19 Kg1, SMF 333097/46; Me25-19 Kg2, SMF 333116/180; Me25-20 Kg1, SMF 333137/22; Me25-20 Kg2, SMF 333155/69; Me25-20 Ku, SMF 333175/47; Me25-21 Kg1, SMF 333197/18; Me25-21 Kg2, SMF 333217/23; Me25-22 Kg2, SMF 333237/52; Me25-23 Kg1, SMF 333260/23; Me25-23 Kg2, SMF 333279/15; Me25-23 Ku, SMF 333297/1; Me25-24 Kg1, SMF 333313/7; Me25-24 Kg2, SMF 333330/3; Me25-24 Ku, SMF 333343/3; Me25-37 Kg1, RGM 541 617/111; Me25-37 Ku, SMF 333359/12; Me25-38 Kg1, SMF 333376/8; Me25-38 Ku, SMF 333393/1; Me25-39 Kg1, SMF 333408/38; Me25-39 Kg2, SMF 333426/45; Me51/3-562, DCS RGA513/many.

Gravity core T87/2/20G (Saalian), 2.81-2.82 m, RGM 569 079c/41.

Gravity core T87/2/20G (Eemian), sample 2.785-2.795 m, RGM 569 085a/795; 2.73-2.74 m, RGM 569 086c/54; 2.67-2.68 m, RGM 569 087b/8; 2.63-2.64 m, RGM 569 089b/1; 2.59-2.60 m, RGM 569 091d/1; 2.54-2.55 m, RGM 569 092b/6; 2.47-2.48 m, RGM 569 095c/117; 2.45-

2.46 m, RGM 569 100b/42; 2.42-2.43 m, RGM 569 119c/592; 2.36-2.37 m, RGM 569 127/738; 2.33-2.34 m, RGM 569 165b/528; 2.30-2.31 m, RGM 569 181d/552; 2.24-2.25 m, RGM 569 189/806, RGM 569 189b/1 (**Fig. 46A**), RGM 569 189c/1 (**Fig. 46B**); 2.21-2.22 m, RGM 569 204/505; 2.18-2.19 m, RGM 569 242d/427; 2.16-2.17 m, RGM 569 254f/620; 2.14-2.15 m, RGM 569 266b/197; 2.14-2.15 m, RGM 569 271b/103; 2.03-2.04 m, RGM 569 284b/274; 1.97-1.98 m, RGM 569 292e/222; 1.91-1.92 m, RGM 569 300c/142; 1.79-1.80 m, RGM 569 303b/23; 1.76-1.77 m, RGM 569 304c/13; 1.72-1.73 m, RGM 569 305c/29; 1.72-1.73 m, RGM 569 313b/348; 1.68-1.69 m, RGM 569 324b/693; 1.61-1.62 m, RGM 569 327c/4; 1.60-1.61 m, RGM 569 328c/3.

Gravity core T87/2/20G (Weichselian), sample 1.58-1.59 m, RGM 569 329c/4; 1.53-1.54 m, RGM 569 330b/3; 1.48-1.49 m, RGM 569 331c/4; 1.43-1.44 m, RGM 569 332d/18; 1.33-1.34 m, RGM 569 333d/9; 1.23-1.24 m, RGM 569 334a/3; 1.03-1.04 m, RGM 569 337c/1; 0.98-0.99 m, RGM 569 338b/1; 0.93-0.94 m, RGM 569 340c/1; 0.87-0.88 m, RGM 569 342b/1; 0.60-0.61 m, RGM 569 350c/1; 0.30-0.31 m, RGM 569 356c/11; 0.25-0.26 m, RGM 569 365c/90.

Gravity core T87/2/20G (Holocene), sample 0.22-0.23 m, RGM 569 366e/103; 0.20-0.21 m, RGM 569 367d/59; 0.19-0.20 m, RGM 569 368d/51; 0.18-0.19 m, RGM 569 369e/82; 0.17-0.18 m, RGM 569 373d/186; 0.16-0.17 m, RGM 569 374e/84; 0.14-0.15 m, RGM 569 375e/259; 0.12-0.13 m, RGM 569 383c/401; 0.11-0.12 m, RGM 569 389c/143; 0.095-0.105 m, RGM 569 391c/33; 0.05-0.06 m, RGM 569 407b/216.

Bologna samples: CJ 72 III-20, RGM 570 408/many juveniles; CJ 72 III-21, RGM 570 446/many; CJ 72 III-21 (bottom), RGM 570 748/many; CJ 72 III-22, MZB (ex RGM 570 643)/many juveniles; CJ 72 III-25 (top), RGM 570 530/many; CJ 72 III-27 (centre), RGM 570 691/many; CR 20, RGM 570 386/many; CR 31, RGM 570 466/many; CR 33, MZB (ex RGM 569 789)/many; CR 34, RGM 570 670/many; CR 39, RGM 570 611/many; CR 42, RGM 570 355/many; CR 68, RGM 570 719/many; CR 70, RGM 570 558/many; J 73-17, RGM 570 633/1; J 73-29, RGM 570 429/20 juveniles; J 74-9, RGM 570 494/many; J 74-10, RGM 569 909/many; J 74-12, RGM 569 818/many; T74-55-6, RGM 570 915/many; T74-65-1, RGM 570 946/many; T74-65-2, RGM 570 886/many; T74-65-10, RGM 570 861/2.

## Discussion

The name of the heteropod *Atlanta inflata* J.E. Gray, 1850 is a junior homonym of the pteropod species *Atlanta inflata* d'Orbigny, 1834, nowadays indicated as *Heliconoides inflata*. Janssen & Seapy (2009a) submitted an application to ICZN to place the name *A. inflata* J.E. Gray, 1850 on the Official List of Specific Names in Zoology, with the endorsement that it is not invalid by reason of its being a junior primary homonym of *Atlanta inflata* d'Orbigny. The request was granted by Opinion 2266 (ICZN, 2011).

The combination *Limacina* (*Striolimacina*) *inflata*, as used



in Janssen (1999: p. 5, abstract), is a blooper and should be read there as *Limacina (Heliconoides) inflata*.

In gravity core T87/2/20G this species was very common in the base of sapropel S5, as well as in the intervals between sapropels S4 and S3 (all Eemian). Above that level the species almost disappears, to become common again at the Weichselian/Holocene transition, clearly indicating a preference for warmer water. Living populations of this species are present in the eastern Mediterranean, but the species is far more common in the western part of the basin (Rampal, 1975, 281ff). In palaeoclimatological studies from the Mediterranean the occurrence of this species is frequently applied as an indicator species for warmer water.

In most of the bottom samples this species is by far the most common pteropod, sometimes occurring in thousands of specimens, only *Styliola subula* reaches comparable quantities in some samples. Practically all specimens belong to the form A, as described by Janssen (2004), shells belonging to the B form are very rare indeed. The possibility that in the worldwide populations of *Heliconoides inflata* cryptic species will be found is strongly suggested by the occurrence of these two forms based on shell morphology, but should be acknowledged by DNA sequencing. Already Rampal (1975: p. 281) suggested that this species might offer a promising 'matériel de choix pour une étude systématique au niveau subspécifique', however, without specifying what characteristics should be looked at.

#### Genus *Limacina* Bosc, 1817

Type species. – *Clio helicina* Phipps, 1774 (by monotypy) = *Limacina helicina* (Phipps, 1774 (Recent)).

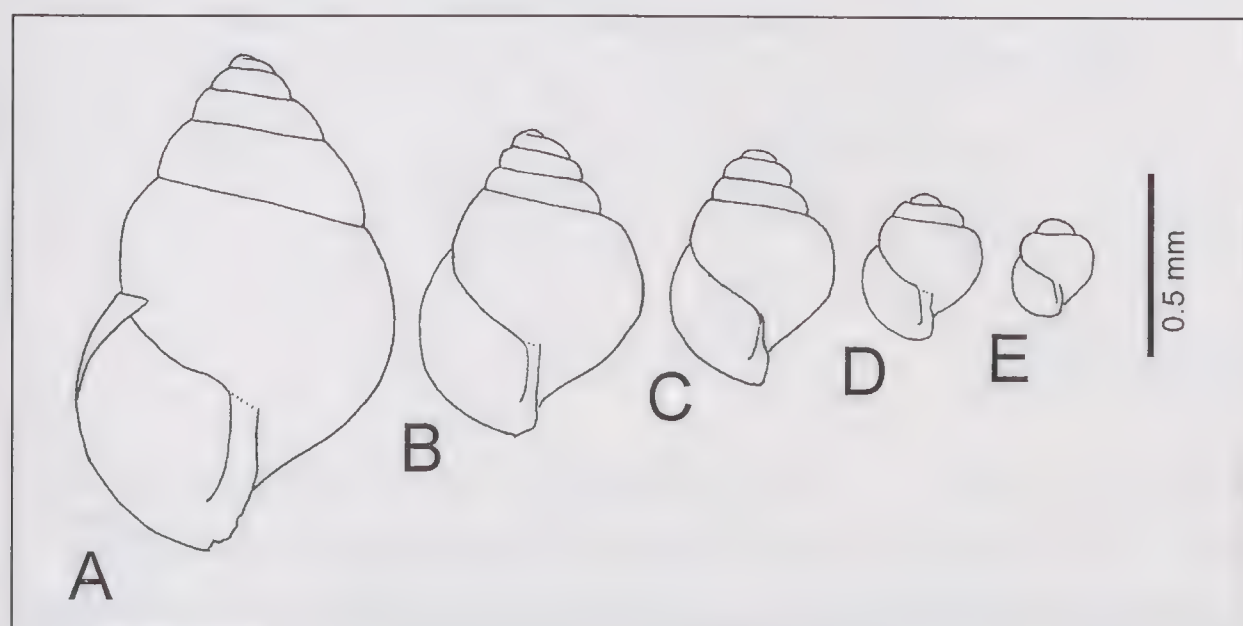
#### *Limacina bulimoides* (d'Orbigny, 1834) (Figs 8A-E, 46C-F)

*A[llanta] [sic] bulimoides* d'Orbigny, 1834: pl. 12, figs 36-38.

*Atlanta (Heliconoides) bulimoides* d'Orb. – d'Orbigny, 1836: p. 179.

*Spirialis bulimoides*, Soul. – Vérany, 1853: p. 381 (non Souleyet).

*Limacina bulimoides* (Orb.) – van Straaten, 1966: p. 431.



**Fig. 8. A-E.** *Limacina bulimoides* (d'Orbigny, 1834), juvenile specimens. Ionian Sea, sample CJ 72 III-25 (top), RGM 570 765. Apertural views.

**Fig. 8. A-E.** *Limacina bulimoides* (d'Orbigny, 1834), esemplari juvenili. Mar Ionio, campione CJ 72 III-25 (top), RGM 570 765. Viste aperturali.

*Limacina (Munthea) bulimoides* (Orbigny, 1836) – van der Spoel, 1967: p. 53, fig. 21.

*Spiratella bulimoides* (d'Orbigny) – Blanc-Vernet et al., 1969: p. 220.

*Limacina bulimoides* (d'Orbigny) – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280ff, pl. 1, figs 6-10.

*Spiratella bulimoides* (d'Orbigny) – Pastouret, 1970: p. 238, pl. 1, fig. 5.

? *Limacina bulimoides* (d'Orbigny) – Di Geronimo, 1970: p. 70, pl. 4, fig. 4 (= *L. trochiformis*?).

*Spiratella bulimoides* (Orb.) – Colantoni et al., 1970: p. 178, pl. 24, figs 5, 6.

*Limacina bulimoides* (d'Orbigny) – Herman, 1971a: p. 617, 618.

*Limacina bulimoides* – Herman, 1971b: p. 475ff, pl. 1, fig. 7.

*Spiratella bulimoides* (Orb.) – Froget & Pastouret, 1972: p. 612ff.

*Spiratella bulimoides* (d'Orbigny) – Vatova, 1974: p. 107.

*Limacina bulimoides* – Rampal, 1975: p. 348.

*Limacina bulimoides* (d'Orbigny) – Bé & Gilmer, 1977: p. 763, pl. 3, fig. 4a-d.

*Limacia bulimoides* – Herman, 1981: p. 189.

*Limacina bulimoides* (d'Orbigny, 1836) – Grecchi, 1984: p. 15, pl. 1, fig. 2.

*Limacina bulimoides* ((d'Orbigny, 1836) – Grecchi & Bertolotti, 1988: p. 102, pl. 1, fig. 4.

*Limacina bulimoides* (d'Orbigny, 1836) – Biekart, 1989: p. 207ff, pl. 1, fig. 1a-e.

*Limacina bulimoides* – Corselli & Grecchi, 1990: p. 98.

*Limacina bulimoides* (d'Orbigny, 1836) – Gofas et al., 2001: p. 200.

*Limacina bulimoides* (d'Orbigny, 1834) – Rosenberg, 2009, Malacolog website.

*Limacina bulimoides* (d'Orbigny, 1834) – WoRMS website, 2011.

*Limacina bulimoides* (d'Orbigny 1836) – CLEMAM website, 2011.

#### Description

See van der Spoel (1967), Bé & Gilmer (1977). Very juvenile specimens may be difficult to distinguish from especially *Limacina trochiformis*. See Fig. 8 and the SEM-images in Biekart (1989) for a comparison of juvenile specimens.

#### Material examined

Box core and beam trawl samples: Me25-15 Kg2, SMF 332943/1; Me25-16 Kg1, RGM 569 488/10; SMF 332979/42, Me25-16 Kg2, SMF 333002/7; Me25-18 Kg2, SMF 333083/1; Me25-20 Kg1, RGM 569 501/3, SMF 333138/11; Me25-20 Kg2, SMF 333156/1; Me25-20 Ku, SMF 333176/1; Me25-21 Kg2, SMF 333218/1; Me51/3-562, DCS RGA514/many.

Gravity core T87/2/20G (Eemian), 1.68-1.69 m, RGM 569 315/1.

Gravity core T87/2/20G (Weichselian), sample 1.53-1.54 m, RGM 569 330c/1; 1.48-1.49 m, RGM 569 331d/1;



1.33-1.34 m, RGM 569 333e/1; 1.23-1.24 m, RGM 569 334b/1; 0.30-0.31 m, RGM 569 356d/4; 0.25-0.26 m, RGM 569 359/35.

Gravity core T87/2/20G (Holocene), sample 0.22-0.23 m, RGM 569 366f/23; 0.20-0.21 m, RGM 569 367e/13; 0.19-0.20 m, RGM 569 368e/11; 0.18-0.19 m, RGM 569 369f/19; 0.17-0.18 m, RGM 569 373e/8; 0.16-0.17 m, RGM 569 374f/3; 0.14-0.15 m, RGM 569 375f/26; 0.12-0.13 m, RGM 569 378/74, RGM 569 378a/1 (**Fig. 46C-E**), RGM 569 378b/1 (**Fig. 46F**); 0.11-0.12 m, RGM 569 389d/28; 0.095-0.105 m, RGM 569 391d/14; 0.05-0.06 m, RGM 569 397/59.

Bologna samples: CJ 72 III-25 (top), RGM 570 531/24, RGM 570 765/5 (**Fig. 8A-E**); CJ 72 III-27 (centre), RGM 570 692/many juveniles; CR 20, RGM 570 387/many; CR 31, RGM 570 467/21; CR 33, MZB (ex RGM 569 790)/30; CR 39, RGM 570 612/many; CR 42, RGM 570 356/8; CR 68, RGM 570 720/many; CR 70, RGM 570 559/many juveniles; J 73-29, RGM 570 430/4 juveniles; J 74-9, RGM 570 495/2, 10 juveniles; J 74-10, RGM 569 910/7 juveniles; J 74-12, RGM 569 819/11 juveniles; T74-55-6, RGM 570 916/c. 40 juveniles; T74-65-1, RGM 570 947/many juveniles; T74-65-2, RGM 570 887/5 juveniles.

## Discussion

Herman (1971a, b) found low numbers of this species in the postglacial and/or interstadial parts of cores in the Levantine Basin, the southern Aegean, the Ionian and the central Tyrrhenian seas. She interpreted the species as a 'low salinity (36‰) Atlantic water indicator, present at low frequencies in all basins' (of the Mediterranean). Vatova (1974) found this species to be common in two bottom samples from the Ionian Sea. Grecchi & Bertolotti (1988) recorded *Limacina bulimoides* from several Holocene samples in core GC-18 (32° 32' 83" N 26° 50' 49' E) and furthermore from just one late Pleistocene sample, taken just below sapropel S3. Corselli & Grecchi (1990), including *L. bulimoides* among the '*specie accidentali*', refer to the few observations of living western Mediterranean specimens and to the abundant occurrence of this species in cores from the eastern Mediterranean, considering it especially common during the Holocene. In core BAN88-11GC, taken south of Crete (Violanti et al., 1991) this species was exclusively present in the upper 40 cm and entirely absent all over the section downwards to 5.55 m below sea bottom.

In gravity core T87/2/20G isolated specimens of *Limacina bulimoides* were found in the top level of the Eemian and the base of the Weichselian interval. The species reappears just before the Weichselian-Holocene boundary and continues until the top of the section in larger numbers (**Tab. 3a, b**), in general acknowledging the above specified distributions. Living specimens in the Mediterranean Sea were reported from the western part of the basin, reaching the Sicilian-Libyan area only (Rampal, 1975: p. 348). The abundance of the species in the uppermost sediments in the Levantine Basin (Grecchi, 1984; Grecchi & Bertolotti, 1988; this paper) indicates

that *L. bulimoides* disappeared from this area only recently.

## *Limacina lesueurii* (d'Orbigny, 1835) (**Fig. 46G, H**)

*Atlanta Lesueurii* d'Orbigny, 1835: pl. 20, figs 12-15.

*Atlanta (Heliconoides) Lesueurii*, d'Orb. – d'Orbigny, 1836: p. 177.

*Limacina (Thilea) lesueurii* (Orbigny, 1836) – van der Spoel, 1967: p. 52, fig. 20 (with additional synonyms).

*Spiratella lesueurii* (d'Orbigny) – Vatova, 1974: p. 107.

*Limacina lesueurii* (d'Orbigny) – Bé & Gilmer, 1977: p. 761, pl. 3, fig. 5a-d; fig. 9.

*Limacina lesueurii* – Herman, 1981: p. 190.

*Limacina lesueurii* – Corselli & Grecchi, 1990: p. 97.

*Limacina lesueurii* (d'Orbigny, 1836) – Gofas et al., 2001: p. 200.

*Limacina lesueurii* (d'Orbigny, 1835) – Rosenberg, 2009Malacolog website.

*Limacina lesueurii* (d'Orbigny, 1836) – WoRMS website, 2011.

*Limacina lesueurii* (d'Orbigny 1836 – CLEMAM website, 2011.

## Description

See van der Spoel (1967), Bé & Gilmer (1977).

## Material examined

Gravity core T87/2/20G (Saalian), 2.81-2.82 m, RGM 569 070/37.

Gravity core T87/2/20G (Eemian), sample 2.785-2.795 m, RGM 569 081/368, RGM 569 081a/1 (**Fig. 46H**), RGM 569 081b/1 (**Fig. 46G**); 2.73-2.74 m, RGM 569 086d/105; 2.67-2.68 m, RGM 569 087c/3; 2.63-2.64 m, RGM 569 089c/1; 2.59-2.60 m, RGM 569 091e/1; 2.54-2.55 m, RGM 569 092c/2; 2.49-2.50 m, RGM 569 093b/1; 2.47-2.48 m, RGM 569 095d/16; 2.42-2.43 m, RGM 569 106/1; 2.24-2.25 m, RGM 569 190/17; 2.21-2.22 m, RGM 569 209/8; 2.16-2.17 m, RGM 569 254g/3; 2.14-2.15 m, RGM 569 256/17; 2.14-2.15 m, RGM 569 271c/1; 2.03-2.04 m, RGM 569 284c/4; 1.97-1.98 m, RGM 569 292f/1; 1.91-1.92 m, RGM 569 300d/1; 1.76-1.77 m, RGM 569 304d/2; 1.72-1.73 m, RGM 569 307/9; 1.68-1.69 m, RGM 569 316/28.

Gravity core T87/2/20G (Weichselian), sample 1.48-1.49 m, RGM 569 331e/1; 1.43-1.44 m, RGM 569 332e/1; 1.33-1.34 m, RGM 569 333f/1; 1.23-1.24 m, RGM 569 334c/1; 1.13-1.14 m, RGM 569 335a/1.

## Discussion

Herman (1981: p. 190) described this species as an indicator of Atlantic water, only occurring near Gibraltar. It is absent from the many cores analysed by her, taken all over the Mediterranean basin. Rampal (1975: p. 340, fig. 84) referred to very few records of living specimens, all in the western Mediterranean. Vatova (1974) recognized a few specimens in two bottom samples from the Ionian



Sea. Corselli & Grecchi (1990) summarized the few Mediterranean records of this species, concluding that these accidental penetrations from the Atlantic find unsuitable conditions in the Mediterranean for reproduction. In core BAN88-11GC, collected south of Crete (Violanti et al., 1991) and penetrating to a depth of more than 5.5 m (to below sapropel S 8), this species was entirely absent. Rampal (2011) found this species 'très rare' in the Alboran Sea.

The presence of this species in core T87/2/20G (Tab. 3b), considering the above records, is at least surprising. *Limacina lesueurii* occurs with 37 specimens in the lowermost sample (of supposed Saalian age), but gets really common during the Eemian interval, with no less than 370 specimens in the basal sample (2.785-2.795 m below sea bottom) continuing almost to the top of the Eemian part in decreasing numbers. Isolated specimens are present in the basal Weichselian sediments, after which the species disappears completely from the samples. It was also absent from all bottom samples investigated for this paper.

*Limacina retroversa* (Fleming, 1823)  
(Figs 9A-F, 10A-E, 47A)

*Trochus lunaris* Gmelin, 1791: p. 3587.

*Fusus retroversus*, Fleming, 1823: p. 498, pl. 15, fig. 2.

*Scaea stenogyra* Philippi, 1844: p. 164, pl. 25, fig. 20.

*Limacina retroversa* (Fleming) – van Straaten, 1966: p. 431.

*Spiratella retroversa* Fleming [sic] – Froget, 1967: p. 2968.

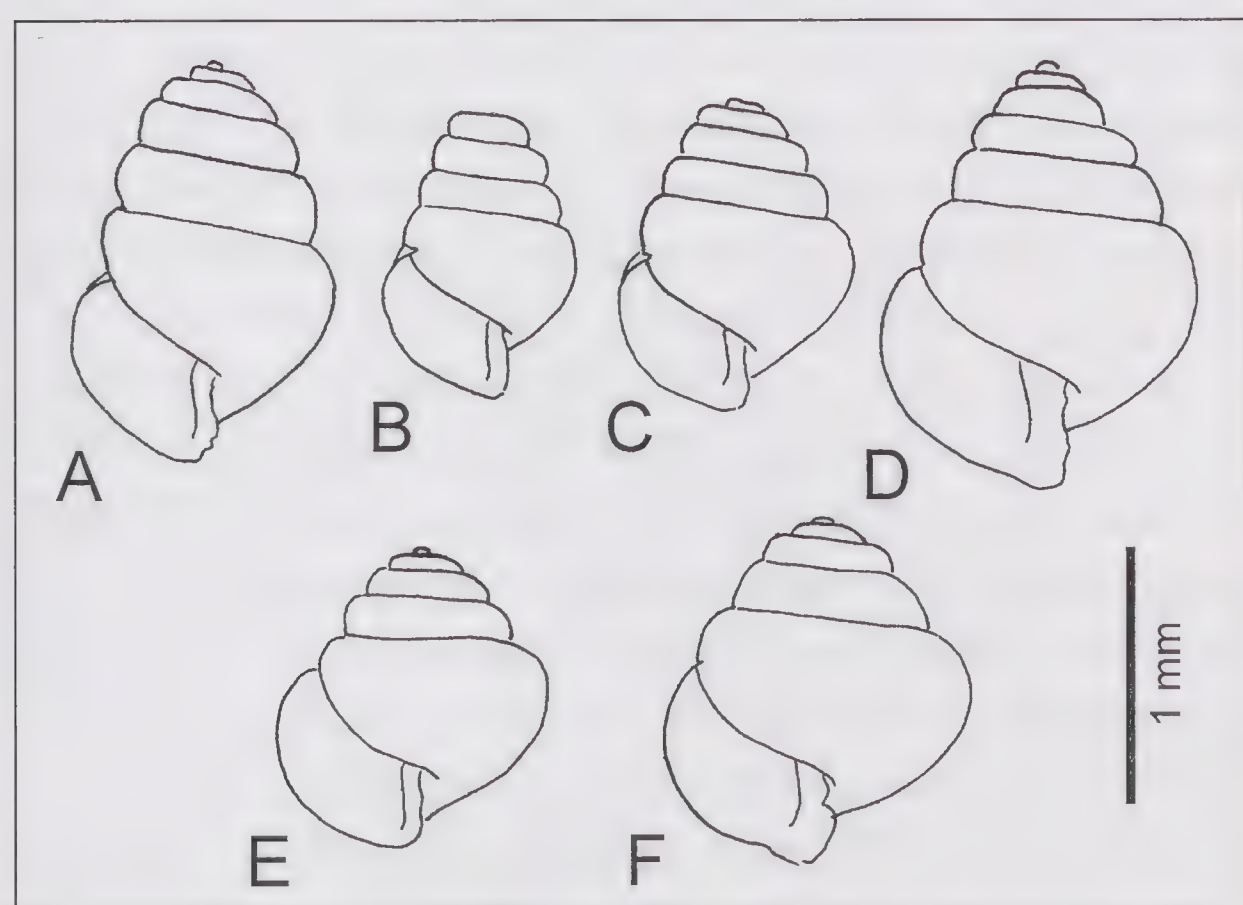
*Spiratella retroversa* (Fleming) – Blanc-Vernet et al., 1969: p. 220.

*Limacina retroversa* (Fleming) – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280ff.

*Spiratella retroversa* (Fleming) – Pastouret, 1970: p. 238, pl. 1, fig. 2, 3.

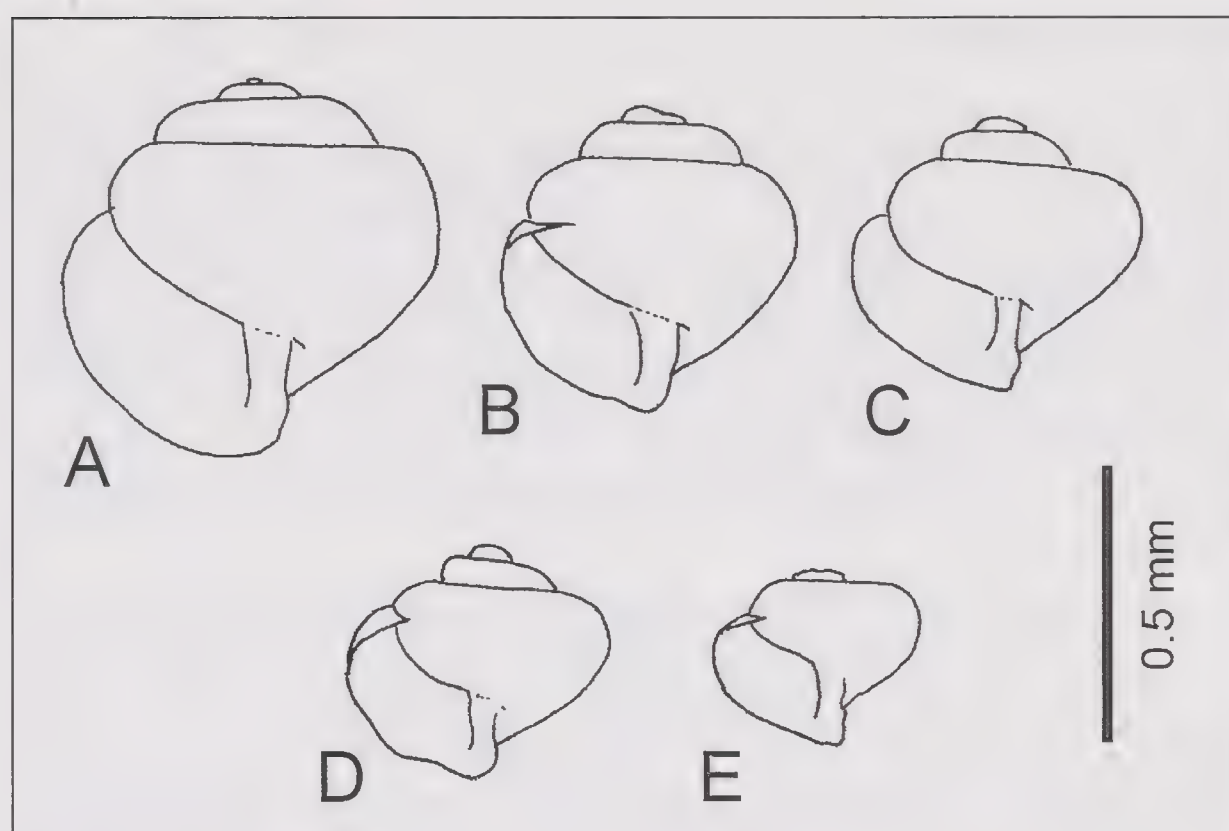
*Spiratella retroversa* (Flem.) – Colantoni et al., 1970: p. 177, pl. 24, figs 1, 2.

*Limacina retroversa* (Fleming) – Herman, 1971a: p. 617-619.



**Fig. 9. A-F.** *Limacina retroversa* (Fleming, 1823), more or less fully grown specimens showing variability in H/W-ratio. Ionian Sea, sample CR 31, RGM 570 766. Apertural views.

**Fig. 9. A-F.** *Limacina retroversa* (Fleming, 1823), esemplari più o meno adulti che mostrano variazioni nel rapporto H/W. Mar Ionio, campione CR 31, RGM 570 766. Viste aperturali.



**Fig. 10. A-E.** *Limacina retroversa* (Fleming, 1823), juvenile specimens, showing change in H/W-ratio during growth. Ionian Sea, sample CR 31, RGM 570 766. Apertural views.

**Fig. 10. A-E.** *Limacina retroversa* (Fleming, 1823), esemplari juvenili che mostrano cambiamenti nel rapporto H/W nel corso della crescita. Mar Ionio, campione CR 31, RGM 570 766. Viste aperturali.

*Limacina retroversa* – Herman, 1971b: p. 475ff.

*Spiratella retroversa* (Fleming) – Froget & Pastouret, 1972: p. 611ff.

? *Spiratella balea* (Moeller 1841) – Nordsieck, 1973: p. 6, fig. 18.

*Spiratella retroversa* (Fleming) – Vatova, 1974: p. 107.

*Limacina* (*Limacina*) *retroversa* (Fleming, 1823) – van der Spoel, 1976: p. 43ff, figs 10,11 (with additional synonymy).

*Limacina retroversa* (Fleming) – Bé & Gilmer, 1977: p. 759, pl. 3, figs 3a-d.

*Limacina retroversa* – Herman, 198, 1p. 193-195.

*Limacina retroversa* (Fleming, 1823) – Grecchi, 1984: p. 14, pl. 1, fig. 1.

*Limacina retroversa* (Fleming) – Buccheri, 1984: p. 80, pl. 1, fig. 1a-c.

*Limacina retroversa* – Vergneau-Grazzini et al., 1988: p. 8, pl. 3, fig. 18.

*Limacina retroversa* (Fleming, 1823) – Grecchi & Bertolotti, 1988: p. 100, pl. 1, fig. 3.

*Limacina retroversa* (Fleming, 1823) – Biekart, 1989: p. 207ff, pl. 1, fig. 4a-c.

*Limacina retroversa* – Corselli & Grecchi, 1990: p. 97.

*Limacina retroversa* – Violanti et al., 1991: p. 24ff.

*Limacina retroversa* (Fleming, 1823) – Gofas et al., 2001: p. 200.

*Limacina retroversa retroversa* (Fleming, 1823) – Rosenberg, 2009, Malacolog website.

*Limacina retroversa* (Fleming, 1823) – WoRMS website, 2011.

*Limacina retroversa* (Fleming 1823) – CLEMAM website, 2011.

## Description

See van der Spoel (1967), Bé & Gilmer (1977). In the present eastern Mediterranean samples shell morphology demonstrates a rather wide variability, especially in the H/W-ratio's. This variability and the shell shape of juvenile specimens is illustrated with outline drawings in Figs 9 and 10. A spiral ornament, as described for *L. retroversa*, could not be observed in the present material.



## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 521/1; Me25-16 Kg1, RGM 569 489/5, SMF 332980/12; Me25-16 Kg2, SMF 333003/23; Me25-18 Kg2, SMF 333084/1; Me25-20 Kg1, RGM 569 500/2, SMF 333139/8; Me25-20 Ku, SMF 333177/5.

Gravity core T87/2/20G (Saalian), sample 2.81-2.82 m, RGM 569 071/1.

Gravity core T87/2/20G (Weichselian), sample 2.14-2.15 m (Eemian), RGM 569 268/1; 0.93-0.94 m, RGM 569 339/7, RGM 569 339a/1 (Fig. 47A); 0.89-0.90 m, RGM 569 341b/6; 0.87-0.88 m, RGM 569 342c/3; 0.84-0.85 m, RGM 569 343a/1; 0.80-0.81 m, RGM 569 344c/2; 0.75-0.76 m, RGM 569 346c/2; 0.72-0.73 m, RGM 569 347b/1; 0.70-0.71 m, RGM 569 348b/1; 0.65-0.66 m, RGM 569 349b/3; 0.60-0.61 m, RGM 569 350d/4; 0.55-0.56 m, RGM 569 351b/3; 0.50-0.51 m, RGM 569 352c/2; 0.40-0.41 m, RGM 569 354b/3; 0.35-0.36 m, RGM 569 355b/3; 0.30-0.31 m, RGM 569 356e/2.

Gravity core T87/2/20G (Holocene), sample 0.20-0.21 m, RGM 569 367f/1; 0.18-0.19 m, RGM 569 369g/2.

Bologna samples: CJ 72 III-22, RGM 570 644/4; CJ 72 III-25, RGM 570 532/many; CJ 72 III-27 (centre), RGM 570 693/many juveniles; CR 20, RGM 570 388/many; CR 31, RGM 570 468/many, RGM 570 766/11 (Figs 9A-F, 10A-E); CR 33, MZB (ex RGM 569 791)/many; CR 34, RGM 570 671/2 juveniles; CR 39, RGM 570 613/21 juveniles; CR 42, RGM 570 357/many; CR 68, RGM 570 721/many juveniles; CR 70, RGM 570 560/c. 30 juveniles; J73-6, RGM 569 901/m; J 73-17, RGM 570 634/many; J 74-9, RGM 570 595/1 juvenile; J 74-10, RGM 569 911/6 juveniles; J 74-12, RGM 569 820/30; J 74-19, RGM 570 482/many; T74-55-6, RGM 570 917/many; T74-65-2, RGM 570 888/many; T74-65-9, RGM 570 931/many; T74-65-10, RGM 570 862/c. 50.

## Discussion

The taxon *Turbo lunaris* Gmelin, 1791 was based on a description and illustration with the name 'Der mondförmige Kräusel' in Chemnitz (1786: pl. 113, fig. 971). As the illustration of fig. 971, according to modern standards, is rather primitive (same as many further illustrations in that work) the name *Turbo lunaris* was considered by most authors (e.g. van der Spoel, 1967; Rosenberg, 2009) to be a questionable junior synonym of *Fusus retroversus* Fleming, 1823. Still, considering shape and size of the illustrated specimen, 'Der mondförmige Kräusel' cannot be anything else than Fleming's species. Following the procedure of ICZN (art. 23.9.2) I make the following statements:

1. Of the names *Turbo lunaris* Gmelin, 1791 and *Fusus retroversus* Fleming, 1823 the latter is valid by prevailing usage;
2. The name *Turbo lunaris* has not been in use after 1899 (van der Spoel, 1967: p. 43) (ICZN 23.9.1.1);
3. The name *Fusus retroversus* Fleming, 1823, usually in combination with other genera, has been used in more

than 25 papers, published by more than 10 authors during the immediate preceding 50 years, encompassing a span of more than 10 years (ICZN 23.9.1.2).

4. These statements make the taxon *Turbo lunaris* to a *nomen oblitum*, and the name *Fusus retroversus* to a *nomen protectum*.

The status of the taxon *Spirialis globulosa* Seguenza, 1867 still is enigmatic (see Janssen, 1995: p. 28) and the discovery of syntypic specimens in the collections of the Museo di Geologia e Paleontologia dell'Università, Florence (Italy) by Bertolaso & Palazzi (2000: p. 22, figs 176-177) has not yet solved its true systematical position. Of 28 syntypic specimens, ranging in size from 0.6 to 2.2 mm, these authors illustrated a relatively small specimen (height 0.9 mm) that is clearly higher than wide. The original illustration in Seguenza (1876, fig. 12) on the contrary shows a specimen that is clearly wider than high, but the dimensions given ('Lunghezza 1,<sup>mm</sup>3, Larghezza 1,<sup>mm</sup>2') are again contradictory to the illustration. The specimens in the Florence collection are labeled '*Spirialis globosus* Seg.' (instead of *globulosa*), which Bertolaso & Palazzi (2000) considered '*evidentemente per lapsus*'. Also the indication of the locality ('Astiano presso Messina') does not give the original locality mentioned in Seguenza (1867) as 'Pagliarino (nel calcare); Rometta, S. Filippo, Trapani (nelle marne)'. These inconsistencies make me strongly hesitate to accept these specimens as syntypes of *S. globulosa* and I do not follow Bertolaso & Palazzi's suggestion that the taxon might be included in the range of variability of *Limacina retroversa*. It would be necessary to see the sample myself, but a request for a loan to the Florence museum was not granted.

The taxonomical status of *Limacina balea* (Möller, 1841) has been (and still is) a long lasting discussion in literature. Bonnevie (1913: p. 14ff) did a statistical analysis on two samples from off the Irish coast and concluded on a specific status of both *L. balea* and *L. retroversa*, mainly based on shell measurements and on differences in the lateral teeth of the radula. She synonymized, however, the antarctic '*Spiriale australe*' (which is a vernacular name for *Spirialis australis* Eydoux & Souleyet, 1840) with *L. balea*. Curiously, she also considered *L. trochiformis* to be a synonym of *L. retroversa*, resulting in a completely erroneous distribution map (Bonnevie, 1913: p. 21, fig. 16) for the latter.

In the same year *Limacina balea* was considered to be a subspecies of *L. retroversa* by Tesch (1913), but a forma of the same by Tesch (1947) and van der Spoel (1967). Rosenberg (2009) treated *L. balea* as a synonym. In 1913 Tesch also considered *Spirialis australis* to be a subspecies of *L. retroversa*, but van der Spoel (1967) reduced its status to a forma. Rosenberg (2009) again listed it as a subspecies. Shell-morphological differences between these taxa are small, and seem to be quite variable and overlapping. *Limacina retroversa* s.str. and *L. balea* also partly cover the same geographical area in the northern Atlantic (van der Spoel, 1967, fig. 337), whereas *L. australis* is restricted to the Antarctic Ocean. This considerable geographical separation makes it more likely that



*L. australis* might be taxonomically separate, but here again DNA sequencing will be helpful to reveal true relationships.

The CLEAM website lists the taxon *Scaea stenogyra* Philippi, 1844 as a dubious synonym of both *Limacina retroversa* and *L. trochiformis*, whereas most authors consider it a junior synonym of *L. retroversa* (e.g. Froget, 1967: p. 2968). The taxon was based on specimens from Quaternary deposits in Calabria and realizing that *L. retroversa* occurs commonly in such deposits in southern Italy (e.g. Caldara et al., 1981: p. 149, tab. 8) I consider *S. stenogyra* a junior synonym of that species. Miocene specimens from Poland, however, recorded as *Spirialis stenogyra* by Kittl (1886: p. 67, pl. 2, figs 35-36) belong to *L. valvatina* (Reuss, 1867) or *L. gramensis* (Rasmussen, 1968) (see Janssen & Zorn, 1993).

Froget (1967) recognized this species in cores collected off Marseille and stresses the importance of the taxon as an indicator of northern Atlantic climatic conditions. Chen (1968: fig. 4) studied a core in the eastern part of the basin (south of Crete), constructing a climatic curve based on the occurrence and absence of *Limacina retroversa* and some species indicating warmer water (*Clio pyramidata*, '*Limacina*' *inflata*, *Styliola subula*, *Creseis conica* and *Creseis 'acicula'*) in which he recognized two periods of glaciation. Blanc-Vernet et al. (1969) analysed a 6.20 m long core taken off the Provence coast at a water depth of 2.460 m, for foraminiferids, pteropods and sediment, and concluded, mainly based on the vertical distribution of *L. retroversa*, compared to the results of the other disciplines, on a very detailed chronostratigraphical interpretation of the last 60 ka. Herman (1971a, b; 1981) found the present species in interstadial and last glacial parts of cores from the Levantine Basin and the southern Aegean, Ionian, central Tyrrhenian and Algero-Provençal seas. Vatova (1974) recorded this species from two bottom samples in the Ionian Sea. Van der Spoel (1976: p. 196) mentioned *Limacina retroversa* from the Mediterranean, east of the Strait of Gibraltar, as migrants from the Atlantic. Grecchi & Bertolotti (1988) recorded numerous specimens of the present species from c. 1-4 m below sea bottom, in core GC-18 (32° 32' 83" N 26° 50' 49' E), interpreted as middle-late Pleistocene. The species was not found in the Holocene part of their section. Corselli & Grecchi (1990) considered *L. retroversa* to be a typical indicator species for colder climates, repeatedly recorded from Pleistocene sediments in the eastern Mediterranean. Violanti et al. (1991) found *Limacina retroversa* to be very common, especially at the level of sapropels S5 and S6, in core BAN88-11GC, taken south of Crete, with hundreds of specimens in some samples. Similar observations were made by other authors. Rampal (2011) discusses differences of this species with other limacinids, but does not report it as a species living in the Mediterranean.

In gravity core T87/2/20G, analyzed for the present paper, however, this species was only found in very small numbers. A single shell was present in the lowermost (Saalien) sample, and also only one shell in the Eemian part, just above sapropel S 4. During the early part of

the Weichselian this species is completely absent, reappearing in small numbers (maximum of 8 shells per sample) in the younger part of that interval. In the Holocene part of the core three specimens were present: one at 20 cm, and two at 18 cm below sea bottom. Many of the bottom samples studied for this paper, usually taking only several tens of cms of the bottom sediments at most, yielded this species in numbers.

***Limacina trochiformis* (d'Orbigny, 1834)  
(Figs 11A-E, 47B-E)**

*A[llanta] trochiformis* d'Orbigny, 1834: pl. 12, figs 29-31.

*Atlanta (Heliconoides) trochiformis* d'Orb. – d'Orbigny, 1836: p. 177.

*Spirialis trochiformis*, Souleyet – Souleyet, in Rang & Souleyet, 1852: p. 64.

*Limacina naticoides* Rang, in Rang & Souleyet, 1852: p. 64, pl. 10, figs 1-2.

? *Spirialis contorta* Monterosato, 1875: p. 50 (*nomen nudum*).

? *Spirialis contorta*, Monts. – Monterosato, 1878: p. 115 (*nomen nudum*).

*Limacina trochiformis* Gray – Oberwimmer, 1898: p. 589 (non J.E. Gray).

*Limacina contorta* (Monterosato) – Sykes, 1905: p. 327, 1 fig.

*Limacina (Munthea) trochiformis* (Orbigny, 1836) – van der Spoel, 1967: p. 53.

*Limacina trochiformis* (d'Orbigny) – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280ff, pl. 1, figs 1-5.

*Spiratella trochiformis* (d'Orbigny) – Pastouret, 1970: p. 238, pl. 1, fig. 4.

*Limacina trochiformis* (d'Orbigny) – Di Geronimo, 1970: p. 68, pl. 4, fig. 3.

*Limacina bulimoides* (d'Orbigny) – Di Geronimo, 1970: p. 70, pl. 4, fig. 4 (non d'Orbigny).

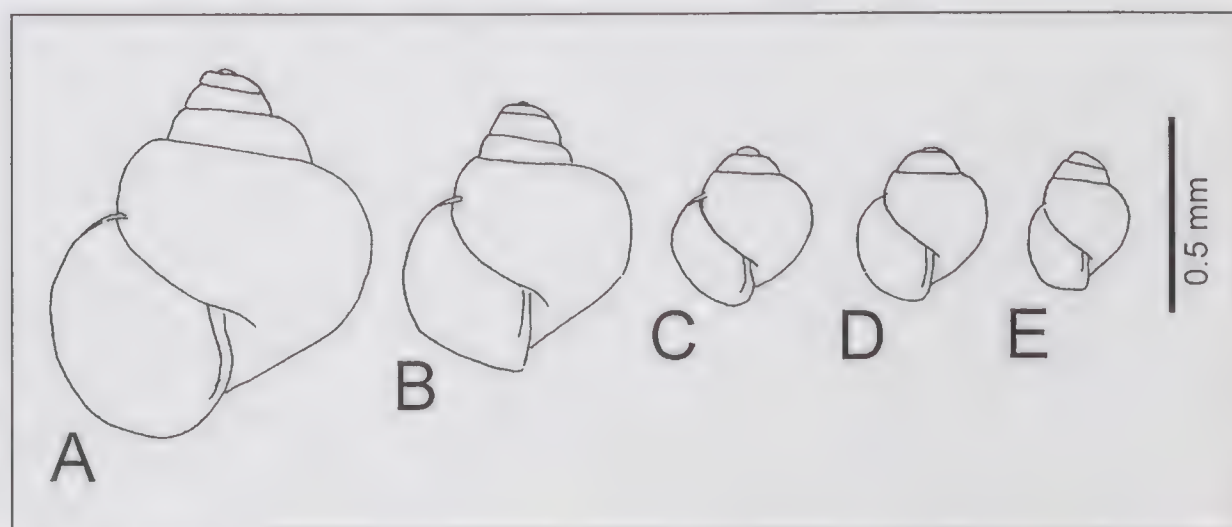
*Spiratella trochiformis* (Orb.) – Colantoni et al., 1970: p. 177, pl. 24, figs 5, 6.

*Limacina trochiformis* (d'Orbigny) – Herman, 1971a: p. 617-619.

*Limacina trochiformis* – Herman, 1971b: p. 475ff, pl. 1, figs 1-6.

*Spiratella trochiformis* (d'Orbigny) – Vatova, 1974: p. 107.

*Limacina trochiformis* Orbigny 1836 – Nordsieck, 1973: p. 6, fig. 19.



**Fig. 11. A-E.** *Limacina trochiformis* (d'Orbigny, 1834), juvenile specimens. Ionian Sea, sample CR 39; RGM 570 767. Apertural views.

**Fig. 11. A-E.** *Limacina trochiformis* (d'Orbigny, 1834), esemplare juvenile. Mar Ionio, campione CR 39; RGM 570 767. Viste aperturali.



*Limacina trochiformis* (d'Orbigny, 1836) – Almogi-Labin & Reiss, 1977: p. 14, pl. 8, figs 1-7; pl. 9, figs 1-3.  
*Limacina trochiformis* (d'Orbigny) – Bé & Gilmer, 1977: p. 769, pl. 3, figs 2a-d; fig. 15.  
*Limacina trochiformis* – Herman, 1981: p. 190.  
*Limacina trochiformis* (d'Orbigny, 1836) – Grecchi, 1984: p. 15, pl. 1, fig. 3.  
*Limacina trochiformis* (d'Orbigny, 1836) – Grecchi & Bertolotti, 1988: p. 103, pl. 1, fig. 2.  
*Limacina trochiformis* (d'Orbigny, 1836) – Biekart, 1989: p. 213ff, pl. 1, fig. a-c.  
*Limacina trochiformis* – Violanti et al., 1991: p. 24ff.  
*Limacina* (*Limacina*) *retroversa* (Fleming, 1823): Bosch et al., 1995: p. 183, fig. 847 (non Fleming).  
*Limacina trochiformis* (d'Orbigny, 1836) – Gofas et al., 2001: p. 200.  
non *Limacina* (*Munthea*) *trochiformis* d'Orbigny, 1836 – Çevik et al., 2006: p. 154, fig. 4 (= dextral. larval shell of benthic gastropod).  
*Limacina trochiformis* (d'Orbigny, 1834) – Rosenberg, 2009, Malacolog website.  
*Limacina trochiformis* (d'Orbigny, 1836) – WoRMS website, e2011.  
*Limacina trochiformis* (d'Orbigny 1836) – CLEMAM website, 2011.

## Description

See Bé & Gilmer (1977). Van der Spoel (1967: p. 53) stated that 'Small specimens of *Limacina retroversa* resemble the present species closely', but such specimens differ clearly, see the drawings given above in **Fig. 10** and drawings of juvenile *L. trochiformis* in **Fig. 11**.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 522/many; Me25-13 Kg2, SMF 332904/1; Me25-15 Kg2, SMF 332944/8; Me25-15 Ku, SMF 332963/3; Me25-16 Kg1, SMF 332981/14; Me25-16 Kg2, SMF 333004/8; Me25-17 Kg1, SMF 333030/11; Me25-17 Kg2, SMF 333050/7; Me25-18 Kg1, SMF 333069/20; Me25-19 Kg1, SMF 333098/15; Me25-19 Kg2, SMF 333117/43; Me25-20 Kg1, SMF 333140/3; Me25-20 Kg2, SMF 333157/22; Me25-20 Ku, SMF 333178/3; Me25-21 Kg1, SMF 333198/9; Me25-21 Kg2, SMF 333219/1; Me25-22 Kg2, SMF 333238/15; Me25-23 Kg1, SMF 333261/21; Me25-23 Kg2, SMF 333280/4; Me25-24 Kg1, SMF 333314/1; Me25-24 Kg2, SMF 333331/1; Me25-37 Kg1, RGM 541 618/37, RGM 541 618a, b (**Fig. 47B, C**); Me25-37 Ku, SMF 333360/2; Me25-38 Kg1, SMF 333377/11; Me25-39 Kg1, SMF 333409/11; Me25-39 Kg2, SMF 333427/8.  
Gravity core T87/2/20G (Saalian), sample 2.81-2.82 m, RGM 569 079d/11.  
Gravity core T87/2/20G (Eemian), sample 2.63-2.64 m, RGM 569 089d/7; 2.59-2.60 m, RGM 569 091f/2; 2.54-2.55 m, RGM 569 092d/2; 2.49-2.50 m, RGM 569 093c/2; 2.47-2.48 m, RGM 569 095e/44; 2.45-2.46 m, RGM 569 100c/16; 2.42-2.43 m, RGM 569 107/174; 2.36-2.37 m, RGM 569 128/278, RGM 569 128a, b /1 (**Fig. 47D, E**);

2.33-2.34 m, RGM 569 165c/64; 2.30-2.31 m, RGM 569 170/14; 2.24-2.25 m, RGM 569 202a/3; 2.21-2.22 m, RGM 569 210/12; 2.18-2.19 m, RGM 569 229/83; 2.16-2.17 m, RGM 569 254h/106; 2.14-2.15 m, RGM 569 266c/22; 2.14-2.15 m, RGM 569 271d/5; 2.03-2.04 m, RGM 569 274/87; 1.97-1.98 m, RGM 569 292g/33; 1.91-1.92 m, RGM 569 300e/2; 1.79-1.80 m, RGM 569 303c/1; 1.72-1.73 m, RGM 569 305d/1.

Gravity core T87/2/20G (Weichselian), sample 0.45-0.46 m, RGM 569 353b/1; 0.25-0.26 m, RGM 569 360/1.

Gravity core T87/2/20G (Holocene), sample 0.05-0.06 m, RGM 569 398/2.

Bologna samples: CJ 72 III-20, RGM 570 409/20 juveniles; CJ 72 III-21, RGM 570 447/2; CJ 72 III-21 (bottom), RGM 570 749/many juveniles; CJ 72 III-22, MZB (ex RGM 570 645)/23; CJ 72 III-25 (top), RGM 570 533/25; CJ 72 III-27 (centre), RGM 570 694/3 juveniles; CR 20, RGM 570 389/18; CR 31, RGM 570 469/9; CR 34, RGM 570 672/19; CR 39, RGM 570 614/many, RGM 570 767/5 (**Fig. 11A-E**); CR 42, RGM 570 358/c. 45; CR 68, RGM 570 722/many; CR 70, RGM 570 561/20 juveniles; J 74-9, RGM 570 496/many; J 74-10, RGM 569 912/4 juveniles; J 74-12, RGM 569 821/22; T74-65-1, RGM 570 948/c. 40 juveniles; T74-65-2, RGM 570 889/c. 50 juveniles.

## Discussion

The name *Spirialis contorta* Monterosato, 1875 was published without a description or illustration, also in several later papers of that author. It was Sykes (1905, figure on p. 327) who validated the name *Limacina contorta* by giving a good illustration, which clearly makes it a junior synonym of *Limacina trochiformis*. Sykes himself already considered it 'nearly related to *L. trochiformis*'. *Limacina trochiformis* was found by Oberwimmer (1898) dead and alive in the eastern Mediterranean, but not in the Adriatic Sea. Herman (1971a, b; 1981 recorded this species from the postglacial and/or interstadial parts of cores in the Aegean, Ionian, central Tyrrhenian and Algero-Provençal seas, as well as from the Levantine Basin, and added the following portrayal: '*Limacina trochiformis*: Is a warm, surface-water species. Its distribution appears to follow that of the surface-water mass, decreasing rapidly east of the Tyrrhenian Sea. *L. trochiformis* is rare north of 40° N. lat.'.

From the Ionian Sea Vatova (1974) mentioned this species as occurring in three bottom samples. Almogi-Labin & Reiss (1977: pl. 8, figs 3, 6) already nicely illustrated the palatal ornament in this species, occurring next to the much more delicate oblique micro-ornament on the base of the shell, both also described and illustrated in Janssen (2007a: p. 152, pl. 16, fig. 1 and pl. 15, fig. 6b, respectively). Grecchi & Bertolotti (1988) recorded this species from core GC-18 (32° 32' 83" N 26° 50' 49" E), as common in the uppermost Holocene sample, in the earlier half of the late Pleistocene and in two middle Pleistocene samples taken just below sapropel S6. Violanti et al. (1991) found a restricted number of specimens in the sapropels S3-S5 interval and some further specimens at the level of sapropels S7 and S8.







- Creseis acicula* Rang – Menzies, 1958: p. 386, fig. 4f-h.  
*Creseis acicula* Rang – van Straaten, 1966: p. 431.  
*Creseis acicula* (Rang, 1828) forma *acicula* (Rang, 1828) – van der Spoel, 1967: p. 58, figs 22-27, 30.  
 non *Creseis acicula* (Rang, 1828) forma *clava* (Rang, 1828) – van der Spoel, 1967: p. 59, figs 28, 29 (= *Creseis conica*).  
*Creseis acicula* (Rang) – Blanc-Vernet et al., 1969: p. 220.  
*Creseis acicula* Rang – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280ff, pl. 1, figs 19-22.  
*Creseis acicula acicula* Rang – Pastouret, 1970: p. 238, pl. 3, fig. 3.  
*Creseis acicula* Rang – Di Geronimo, 1970: p. 79, pl. 3, fig. 4 (mala); pl. 4, fig. 6a-d.  
*Creseis acicula* (Rang) – Colantoni et al., 1970: p. 179, pl. 24, fig. 11.  
*Creseis acicula* Rang – Herman, 1971a: p. 617, 618.  
*Creseis acicula* – Herman, 1971b: p. 475ff, pl. 2, figs 1-2.  
*Creseis acicula* (Rang) – Froget & Pastouret, 1972: p. 612ff.  
*Creseis acicula* Rang 1828 juvenil – Nordsieck, 1973: p. 6, fig. 24.  
*Creseis acicula* Rang – Vatova, 1974: p. 108.  
*Creseis acicula* forma *acicula* Rang: van der Spoel, 1976b: p. 189 (with lectotype designation)  
*Creseis acicula* forma *clava* Rang: van der Spoel, 1976b: p. 189 (with lectotype designation).  
*Creseis acicula* (Rang, 1828) – Almogi-Labin & Reiss, 1977: p. 10, pl. 4, figs 1-3.  
*Creseis acicula* (Rang) – Bé & Gilmer, 1977: p. 777, 20. pl. 5, fig. 11a, b.  
*Creseis acicula* – Herman, 1981: p. 189.  
*Creseis acicula* Rang, 1828 – Grecchi, 1984: p. 15, pl. 1, fig. 14.  
 ? *Creseis virgula* Rang – Buccheri, 1984: p. 80, pl. 1, fig. 9 (non *virgula* Rang).  
*Creseis acicula* (Rang) – Buccheri & di Stefano, 1984: p. 182, pl. 1, fig. 7.  
*Creseis acicula* – Vergneau-Grazzini et al., 1988: p. 8, pl. 3, fig. 15.  
*Creseis acicula* (Rang, 1828) – Grecchi & Bertolotti, 1988: p. 104, pl. 1, fig. 7.  
*Creseis acicula* (Rang, 1828) – Biekart, 1989: p. 207ff, pl. 2, fig. 1a, b.  
*Creseis acicula* (Rang, 1828 – Gofas et al., 2001: p. 200.  
*Creseis acicula* (Rang, 1828) – Rampal, 2002: p. 231, figs 9A-J, 11.  
*Creseis clava* (Rang, 1828) – Janssen, 2007b: p. 68, text-fig. 7b-d; pl. 2, figs 9, 10; pl. 23, figs 7, 8 (with further synonyms).  
*Creseis acicula* (Rang, 1828) – Rosenberg, 2009, Malacolog website.  
*Creseis acicula* Rang, 1828 – WoRMS website, 2011.  
*Creseis acicula* Rang 1828 – CLEMMAM website, 2011.  
 Pteropod (*Creseis acicula* (Rang, 1828); holotype of *Dentalium ecostatum* Kirk, 1880) – Museum of New Zealand, 2011, website.

## Description

See Bé & Gilmer (1977), Rampal (2002) Janssen (2007b).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 523/many; Me25-11 Kg1, SMF 332865/3; Me25-12 Kg2, SMF 332875/3; Me25-13 Kg1, SMF 332888/4; Me25-13 Kg2, SMF 332905/7; Me25-15 Kg1, SMF 332925/12; Me25-15 Kg2, SMF 332945/5; Me25-15 Ku, SMF 332964/2; Me25-16 Kg1, SMF 332982/22; Me25-16 Kg2, SMF 333005/7; Me25-17 Kg1, SMF 333031/22; Me25-17 Kg2, SMF 333051/21; Me25-18 Kg1, SMF 333070/1; Me25-19 Kg1, SMF 333099/8; Me25-19 Kg2, SMF 333118/20; Me25-20 Kg2, SMF 333158/1; Me25-20 Ku, SMF 333179/12; Me25-21 Kg1, SMF 333199/18; Me25-21 Kg2, SMF 333220/4; Me25-22 Kg2, SMF 333239/2; Me25-23 Kg1, SMF 333262/23; Me25-23 Kg2, SMF 333281/28; Me25-23 Ku, SMF 333298/32; Me25-24 Kg1, SMF 333315/3; Me25-24 Kg2, SMF 333332/15; Me25-37 Kg1, RGM 541 619/135; Me25-37 Ku, SMF 333361/25; Me25-38 Kg1, SMF 333378/5; Me25-38 Ku, SMF 333394/2; Me25-39 Kg1, SMF 333410/2; Me25-39 Kg2, SMF 333428/12; Me51/3-562, DCS RGA515/many.  
 Gravity core T87/2/20G (Saalian), sample 2.81-2.82 m, RGM 569 079e/1, 1 fragment.  
 Gravity core T87/2/20G (Eemian), sample 2.785-2.795 m, RGM 569 085b/7; 2.73-2.74 m, RGM 569 086e/4 fragments; 2.36-2.37 m, RGM 569 129/12; 2.33-2.34 m, RGM 569 165d/4; 2.24-2.25 m, RGM 569 202b/1; 2.21-2.22 m, RGM 569 225b/1.  
 Gravity core T87/2/20G (Weichselian), sample 0.30-0.31 m, RGM 569 356f/5; 0.25-0.26 m, RGM 569 365d/1.  
 Gravity core T87/2/20G (Holocene), sample 0.22-0.23 m, RGM 569 366g/7; 0.20-0.21 m, RGM 569 367g/3; 0.18-0.19 m, RGM 569 369h/8; 0.17-0.18 m, RGM 569 373f/1; 0.16-0.17 m, RGM 569 374g/3; 0.05-0.06 m, RGM 569 407c/2.  
 Bologna samples: CJ 72 III-20, RGM 570 410/c. 30 juveniles; CJ 72 III-21, RGM 570 448/6; CJ 72 III-21 (bottom), RGM 570 750/c. 30; CJ 72 III-22, MZB (ex RGM 570 646)/28; CJ 72 III-25 (top), RGM 570 534/13; CJ 72 III-27 (centre), RGM 570 695/c. 30 juveniles; CR 20, RGM 570 390/many; CR 31, RGM 570 470/8; CR 33, MZB (ex RGM 569 792)/25; CR 34, RGM 570 673/many; CR 39, RGM 570 615/many; CR 42, RGM 570 359/many; CR 68, RGM 570 723/many; CR 70, RGM 570 563/many; J 73-29, RGM 570 431/1 juvenile; J 74-9, RGM 570 497/many; J 74-10, RGM 569 913/4 juveniles; J 74-12, RGM 569 822/35; T74-65-1, RGM 570 949/many; T74-65-2, RGM 570 890/many; T74-65-10, RGM 570 863/1 fragment.

## Discussion

The application of the name *Creseis clava* for this species, instead of *C. acicula*, was extensively discussed in Janssen (2007b: p. 69ff). Contrary to that paper I now consider *Creseis acicula* forma *clava*, as described in van der Spoel (1967: p. 59) to belong to *C. conica*, as in his dichotomic key on p. 58 he gave as characteristic difference '.... rapidly increasing in width', which clearly points to *C. conica*.

In gravity core T87/2/20G (Tab. 3a, b) *Creseis clava* is



present in low numbers during the early half of the Eemian interval and reappears, also in small numbers, at the Weichselian/Holocene boundary. In many of the bottom sediment samples, however, this species is not rare, and sometimes even commonly present.

A living population was recently photographed (Fig. 12) in shallow water along the Maltese coast. I thank Julian Evans for the permission to include his picture here.

*Creseis chierchiae* (Boas, 1886)

f. *constricta* Chen & Bé, 1964

non *Creseis chierchiae* Boas – Menzies, 1958: p. 386, fig. 2C, D (not 2E; non Boas = ‘beaked larva’ *sensu* van der Spoel & Newman, 1990).

*Creseis virgula constricta* Chen & Bé, 1964: p. 194, figs 3d, 4d.

C[reseis] *virgula* [Rang] *constricta* Chen [sic] – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280, pl. 1, figs 27, 28.

*Creseis chierchiae* (Boas) – Rampal, [1975]: p. 12ff, fig. 2 (16).

*Creseis virgula* (Rang, 1828) *constricta* (Chen and Bé) [sic] – Bé & Gilmer, 1977: p. 49ff, pl. 5, fig. 12a, b.

*Creseis chierchiae* – Ivanova, 1985: p. 352ff, pl. 3, figs 3, 4.

*Creseis chierchiae* (Boas, 1886) forma *constricta* Chen & Bé, 1964 – Janssen, 2007b: p. 65, pl. 2, figs 7, 8; pl. 23, figs 3-6 (with extensive synonymy).

## Description

See Chen & Bé (1964), Bé & Gilmer (1977), Janssen (2007b).

## Discussion

This taxon is absent from the material analyzed for this paper. Vergnaud Grazzini & Herman Rosenberg (1969) listed and illustrated it from core V 10.67, collected W of Crete in the Ionian Sea, but without an indication from which part of the core their specimens were collected. Rampal (1975: p. 12; 2011) considered the presence of this form in the Mediterranean ‘*peu probable*’.

The CLEMAM website (2011) erroneously lists ‘*Creseis virgula constricta*’ as a synonym of *C. virgula*.

*Creseis conica* Eschscholtz, 1829

(Fig. 47F-J)

*Creseis conica* Eschscholtz, 1829: p. 17, pl. 15, fig. 3.

*Creseis striata* – delle Chiaje, 1830: pl. 82, fig. 12 (non *C. striata* Rang).

*Creseis virgula*. Rang – Deshayes, 1853: p. 62, pl. 103, fig. 14 (non Rang) (non ig. 13 (= *C. virgula*)).

? *Cleodora virgula*, Rang – Vérany, 1853: p. 380 (non Rang).

*Styliola vitrea* Verrill, 1872: p. 284, pl. 6, fig. 7.

*Creseis rotunda* Sowerby in Reeve & Sowerby, 1878: pl. 5, fig. 28a, b.

? *Clio* (*Creseis*) *virgula* Pels. – Oberwimmer, 1898: p. 589. (non Pelseneer).

*Clio* (*Creseis*) *conica* Eschsch. – Oberwimmer, 1898: p. 589.

*Creseis virgula* Rang – Menzies, 1958: p. 385, fig. 3c-e (non *virgula* Rang).

*Creseis virgula* Rang – van Straaten, 1966: p. 431 (non Rang).

*Creseis acicula* (Rang, 1828) forma *clava* (Rang, 1828) – van der Spoel, 1967: p. 59, figs 28, 29.

non *Creseis virgula* (Rang, 1828) forma *conica* Eschscholtz, 1829 – van der Spoel, 1967: p. 60, fig. 31; figs 33-35, 39?) (= *Creseis virgula*).

*Creseis virgula* (Rang, 1828) forma *virgula* (Rang, 1828) – van der Spoel, 1967: p. 61, fig. 32 (non Rang).

?non *Creseis conica* Eschscholtz – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280, pl. 1, figs 13-17 (non Eschscholtz = *Creseis virgula*?).

*Creseis virgula conica* Eschscholtz – Pastouret, 1970: p. 238, pl. 3, fig. 2.

*Creseis virgula* (Rang, 1828 – Di Geronimo, 1970: p. 77, pl. 3, fig. 6; pl. 4, fig. 1a-d (non Rang)).

*Creseis conica* Eschscholtz – Herman, 1971a: p. 617.

*Creseis conica* – Herman, 1971b: p. 475ff, pl. 2, figs 3, 4.

*Creseis virgula* (Rang) – Froget & Pastouret, 1972: p. 612ff.

*Creseis virgula* Rang – Vatova, 1974: p. 108.

*Creseis virgula* (Rang, 1828) forma *conica* Eschscholtz, 1829 – Almogi-Labin & Reiss, 1977: p. 11, pl. 4, figs 6-8.

*Creseis virgula* – Herman, 1981: p. 189.

*Creseis virgula* Rang, 1828 – Grecchi, 1984: p. 15, pl. 1, fig. 6 (non Rang).

*Creseis virgula* Rang – Buccheri & di Stefano, 1984: p. 182, pl. 1, fig. 8.

*Creseis virgula* (Rang, 1828) – Grecchi & Bertolotti, 1988: p. 105, pl. 1, fig. 8 non Rang).

*Creseis virgula* (Rang, 1828) forma *conica* Eschscholtz, 1829 – Biekart, 1989: p. 207ff, pl. 2, fig. 2a, b.

*Creseis acicula* (Rang, 1828) – Bosch et al., 1995: p. 182, fig. 846 (non Rang).

*Creseis virgula* Rang, 1828 – Gofas et al., 2001: p. 200.

*Creseis conica conica* Escholtz [sic] – Rampal, 2002: p. 233, figs 9K-O, 11.

*Creseis conica falciformis* Rampal, 2002: p. 233, figs 9P-T, 11.

*Creseis conica* Eschscholtz, 1829 – Janssen, 2007: p. 153, pl. 17, figs 3, 4.

*Creseis conica* Eschscholtz, 1829 – Rosenberg, 2009, Malacolog website.

*Creseis conica* – WoRMS website, 2011.

*Creseis conica falciformis* Rampal, 2002 – WoRMS website, 2011.

*Creseis virgula* Rang 1828 – CLEMAM website, 2011 (partim, excl. synonymy).

## Description

See Rampal (2002), Janssen (2007a). As stated by both mentioned authors this species has frequently been referred to in literature with the name *Creseis clava* and/or *C. virgula* (Rang, 1828).



## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 524/many; Me25-11 Kg1, SMF 332866/1; Me25-13 Kg1, SMF 332889/2; Me25-13 Kg2, SMF 332906/1; Me25-15 Kg1, SMF 332926/6; Me25-16 Kg1, SMF 332983/5; Me25-16 Kg2, SMF 333006/11; Me25-17 Kg1, SMF 333032/28; Me25-17 Kg2, SMF 333052/19; Me25-18 Kg2, SMF 333085/2; Me25-19 Kg1, SMF 333100/2; Me25-19 Kg2, SMF 333119/41; Me25-20 Kg2, SMF 333159/6; Me25-20 Ku, SMF 333180/3; Me25-21 Kg1, SMF 333200/26; Me25-21 Kg2, SMF 333221/2; Me25-22 Kg2, SMF 333240/5; Me25-23 Kg1, SMF 333263/2; Me25-23 Kg2, SMF 333282/5; Me25-23 Ku, SMF 333299/1; Me25-24 Kg1, SMF 333316/1; Me25-24 Kg2, SMF 333333/5; Me25-37 Kg1, RGM 541 620/493, RGM 541 620a, b /2 (Fig. 47G-I); Me25-38 Kg1, SMF 333379/7; Me25-39 Kg1, SMF 333411/3; Me25-39 Kg2, SMF 333429/4.

Gravity core T87/2/20G (Saalian), sample 2.81-2.82 m, RGM 569 079f/8; Me51/3-562, DCS RGA502/4.

Gravity core T87/2/20G (Eemian), sample 2.785-2.795 m, RGM 569 085c/1, RGM 569 129a/1 (Fig. 47F); 2.73-2.74 m, RGM 569 086f/46; 2.67-2.68 m, RGM 569 087d/27; 2.63-2.64 m, RGM 569 089e/8; Gravity core T87/2/20G, 2.59-2.60 m, RGM 569 091g/8; 2.54-2.55 m, RGM 569 092e/3; 2.49-2.50 m, RGM 569 093d/1; 2.47-2.48 m, RGM 569 095f/19; 2.42-2.43 m, RGM 569 108/18; 2.36-2.37 m, RGM 569 1230/32, RGM 569 130a/1 (Fig. 47J); 2.33-2.34 m, RGM 569 165e/25; 2.30-2.31 m, RGM 569 181e/22; 2.24-2.25 m, RGM 569 202c/28; 2.21-2.22 m, RGM 569 211/6; 2.18-2.19 m, RGM 569 242e/2; 2.03-2.04 m, RGM 569 275/5; 1.97-1.98 m, RGM 569 292h/2; 1.91-1.92 m, RGM 569 300f/1; 1.72-1.73 m, RGM 569 305e/1. Gravity core T87/2/20G (Holocene), sample 0.17-0.18 m, RGM 569 373g/1; 0.14-0.15 m, RGM 569 375g/5; 0.12-0.13 m, RGM 569 383d/3; 0.11-0.12 m, RGM 569 389e/3; 0.095-0.105 m, RGM 569 391e/3; 0.05-0.06 m, RGM 569 407d/5.

Bologna samples: CJ 72 III-20, RGM 570 411/c. 45 juveniles; CJ 72 III-21, RGM 570 449/13; CJ 72 III-21 (bottom), RGM 570 751/many; CJ 72 III-22, MZB (ex RGM 570 647)/many; CJ 72 III-25 (top), RGM 570 535/25; CJ 72 III-27 (centre), RGM 570 696/19 juveniles; CR 20, RGM 570 391/many; CR 31, RGM 570 471/c. 50; CR 33, MZB (ex RGM 569 793)/>50; CR 34, RGM 570 674/many; CR 39, RGM 570 616/many; CR 42, RGM 570 360/many; CR 68, RGM 570 724/many; CR 70, RGM 570 564/many; J 73-29, RGM 570 432/1 juvenile; J 74-9, RGM 570 498/many; J 74-10, RGM 569 914/15 juveniles; J 74-12, RGM 569 823/c. 50; T74-55-6, RGM 570 918/2 juveniles; T74-65-1, RGM 570 950/many; T74-65-2, RGM 570 891/many.

## Discussion

The long-term confusion that existed in literature between the various *Creseis* species may now be considered to be solved (Janssen, 2007b). Also the distinction between *Creseis conica* and *C. virgula* is clear: the former

species has a straight or lengthwise gradually curved shell, in the latter the shell is strongly curved in its apical third and straight towards the aperture and the shell increases more rapidly in diameter. Van der Spoel (1967) unfortunately mixed up these two.

Rosenberg (2009) and CLEMAM (2011) listed the taxon *Creseis rotunda* Sowerby, 1878 as a synonym of *C. 'aciculata'*, but the illustration clearly shows a specimen with a relatively wide apical angle, representing a straight specimen of *C. conica*.

Menzies (1958) recorded this species as the most abundant pteropod in the eastern Mediterranean, being 3-2000 times more common than the next most abundant species *C. acicula* (= *C. clava*). Herman (1981) most probably referred to this species with the name *Creseis virgula*, recording it from the postglacial and/or interstadial parts of cores from the Ionian, central Tyrrhenian and Algero-Provençal seas. According to her '*C. virgula*' is an epiplanktonic tropical-subtropical species present in all basins (of the Mediterranean), reaching peak abundances in the Ligurian Sea, the Gulf of Lyon, along the French and Spanish coasts, and in the Aegean Sea.'. Corselli & Grecchi (1990: p. 93) also referred to the present species with the name *C. virgula*, accepting the occurrence of living populations both in the western and eastern Mediterranean. Rampal (2011) found this species frequently all over the Mediterranean.

In gravity core T87/2/20G (Tab. 3a, b) *Creseis conica* was found to be present in varying numbers (up to 46 specimens per sample) during the Eemian and Holocene intervals, but was completely absent during the Weichselian.

### Genus *Hyalocylix* Fol, 1875

Type species – '*Hyalocylix striata* = *Cleodora striata* (Rang)' (by original designation) (Recent).

### *Hyalocylix striata* (Rang, 1828) (Fig. 48A-L)

*C[leodora (Creseis)] striata* Rang, 1828: p. 315, pl. 17, fig. 3.

*Creseis compressa* Eschscholtz, 1829: p. 18, pl. 15, fig. 7.

*Creseis zonata* delle Chiaje, 1830: pl. 82, fig. 9.

*Creseis striata*. Rang – Cantraine, 1841: p. 32, pl. 1, fig. 10.

*Creseis annulata*. Rang, – Deshayes, 1853: p. 62, pl. 103, figs 11, 12 (non Rang).

*Clio (Hyalocylix) striata* Pels. – Oberwimmer, 1898: p. 590.

*Hyalocylix striata* Rang – Steuer, 1911: p. 718, fig. 2.

*Hyalocylix striata* (Rang) – Menzies, 1958: p. 388, fig. 3a, b.

*Hyalocylix striata* (Rang) – van Straaten, 1966: p. 431.

*Hyalocylix striata* (Rang, 1828) – van der Spoel, 1967: p. 64, figs 46a, b, 47, 347 (non fig. 42 = erroneous combination of two species).

*Hyalocylix striata* (Rang) – Pastouret, 1970: p. 238, pl. 1, fig. 6.



*Hyalocylix striata* (Rang) – Di Geronimo, 1970: p. 84, pl. 3, fig. 3; pl. 4, fig. 5a, b.  
*Hyalocylix striata* (Rang) – Colantoni et al., 1970: p. 180, pl. 24, fig. 9.  
*Hyalocylix striata* (Rang) – Herman, 1971a: p. 617-619.  
*Hyalocylix striata* – Herman, 1971b: p. 475ff, pl. 1, fig. 11.  
*Hyalocylix striata* (Rang) – Froget & Pastouret, 1972: p. 612ff.  
*Hyalocylix obtusa* Di Geronimo, 1974a: p. 114, figs 1a, b, 2a, b, 3a, b.  
*Hyalocylix striata* (Rang) – Vatova, 1974: p. 108.  
*Hyalocylix striata* (Rang) – Richter, 1976: p. 145ff, text-fig. 4 (shell), 7 (radula).  
*Hyalocylix striata* (Rang, 1828) – Almogi-Labin & Reiss, 1977: p. 13, pl. 6, figs 6-8 (non fig. 5).  
*Hyalocylix striata* (Rang) – Bé & Gilmer, 1977: p. 770, figs 9a, b, 16.  
*Hyalocylix striata* – Herman, 1981: p. 189.  
*Hyalocylix striata* (Rang, 1828) – Grecchi, 1984: p. 16, pl. 1, fig. 4.  
*Hyalocylix striata* (Rang) – Buccheri, 1984: p. 80, pl. 1, fig. 7.  
*Hyalocylix striata* (Rang) – Buccheri & di Stefano, 1984: p. 182, pl. 1, fig. 9.  
*Hyalocylix striata* (Rang, 1828) – Grecchi & Bertolotti, 1988: p. 107, pl. 1, fig. 10.  
*Hyalocylix obtusa* – Corselli & Grecchi, 1990: p. 96.  
*Hyalocylix striata* (Rang, 1828) – Kunz, [1996]: p. 94, pl. 11, figs 1-4.  
*Hyalocylix obtusa* Di Geronimo, 1974 – Gofas et al., 2001: p. 200.  
*Hyalocylix striata* (Rang, 1828) – Gofas et al., 2001: p. 200.  
*Hyalocylix striata* (Rang, 1828) – Rosenberg, 2009, Malacolog website.  
*Hyalocylix striata* (Rang, 1828) – WoRMS website, 2011.  
*Hyalocylix striata* (Rang 1828) – CLEMAM website, 2011.

## Description

See van der Spoel (1967), Di Geronimo (1970), Bé & Gilmer (1977).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 525/many; Me25-11 Kg1, SMF 332867/2; Me25-12 Kg2, SMF 332876/1; Me25-13 Kg1, SMF 332890/12; Me25-13 Kg1; Me25-15 Kg1, SMF 332927/7; Me25-15 Kg2, SMF 332946/5; Me25-16 Kg1, SMF 332984/25; Me25-16 Kg2, SMF 333007/3; Me25-17 Kg1, SMF 333033/13; Me25-17 Kg2, SMF 333053/29; Me25-18 Kg1, SMF 333071/5; Me25-18 Kg2, SMF 333086/5; Me25-19 Kg1, SMF 333101/27; Me25-19 Kg2, SMF 333120/18; Me25-20 Kg2, SMF 333160/3; Me25-20 Ku, SMF 333181/8; Me25-21 Kg1, SMF 333201/3; Me25-21 Kg2, SMF 333222/5; Me25-22 Kg2, SMF 333241/1; Me25-23 Kg1, SMF 333264/17; Me25-23 Kg2, SMF 333283/10;

Me25-23 Ku, SMF 333300/10; Me25-24 Kg1, SMF 333317/7; Me25-24 Kg2, SMF 333334/30; Me25-37 Kg1, RGM 541 621/296, RGM 541 621a, b /2 (**Fig. 48A, B**), RGM 541 622/8, RGM 541 622a-c/3 (**Fig. 48C-G**) (f. *obtusa*); Me25-37 Ku, SMF 333362/22; Me25-38 Kg1, SMF 333380/18; Me25-39 Kg1, SMF 333412/2; Me25-39 Kg2, SMF 333430/4.

Gravity core T87/2/20G (Eemian), sample 2.785-2.795 m, RGM 569 085d/1 fragment; Gravity core T87/2/20G, 2.73-2.74 m, RGM 569 086g/2 fragments; 2.49-2.50 m, RGM 569 093e/1 fragment; 2.47-2.48 m, RGM 569 095g/2 fragments; 2.45-2.46 m, RGM 569 100d/1 fragment; 2.42-2.43 m, RGM 569 109/2, 1 protoconch, RGM 569 109a/1 protoconch (**Fig. 48L**); 2.36-2.37 m, RGM 569 131/10, 3 protoconchs, RGM 569 131a/1 protoconch (**Fig. 48K**); 2.33-2.34 m, RGM 569 153/4, 12 protoconchs; 2.30-2.31 m, RGM 569 171/17 protoconchs, RGM 569 171a/1 protoconch (**Fig. 48I**); 2.24-2.25 m, RGM 569 191/11, 37 protoconchs, RGM 569 191a/1 protoconch (**Fig. 48J**); 2.21-2.22 m, RGM 569 212/6, 29 protoconchs, RGM 569 212a/1 protoconch (Fig. 48H); 2.18-2.19 m, RGM 569 242f/4 protoconchs; 2.16-2.17 m, RGM 569 244/5 protoconchs; 2.14-2.15 m, RGM 569 257/2 protoconchs; 2.03-2.04 m, RGM 569 284d/1 protoconch.

Gravity core T87/2/20G (Holocene), sample 0.14-0.15 m, RGM 569 375h/1 fragment; 0.12-0.13 m, RGM 569 383e/1 fragment.

Bologna samples: CJ 72 III-25 (top), RGM 570 536/1; CR 20, RGM 570 392/4; CR 31, RGM 570 472/5; CR 33, MZB (ex RGM 569 794)/1; CR 34, RGM 570 675/3; CR 39, RGM 570 617/20; CR 42, RGM 570 361/10, RGM 570 362/1 protoconch; CR 68, RGM 570 725/13; CR 70, RGM 570 566/1, 1 fragment; J 74-9, RGM 570 499/19, RGM 570 596/24 protoconchs, RGM 570 500/1 (f. *obtusa*); J 74-12, RGM 569 828/3; T74-65-2, RGM 570 892/2 fragments.

## Discussion

By far most specimens in shell preservation from bottom samples are found with their apical shell part as a simple opening, which is more difficult to observe in internal moulds. Obviously, during lifetime of the specimens, after shedding or, more probably, dissolution of the protoconch, the apex must have been closed with an organic tissue, that disappears soon after death of the animal. This explains why the larval shell of this species remained practically unknown for a long time, as discussed in Janssen (2007a: p. 154). In the present material specimens with a calcified closing septum (van der Spoel, 1967: fig. 46b; Janssen, 2007a: pl. 18, fig. 4) were also absent, but shells with a closed and wrinkled apical portion are occasionally found (Fig. 48C, E-G). These seem to occur in specimens in which also the organic tissue already tends to dissolve during lifetime of the animal, which necessitates precipitation of calcareous matter on the inner surface of the tissue, as explained by Bandel & Hemleben (1995: p. 231). The occurrence of calcified protoconchs is supposed to depend on local environmental circumstances, as demonstrated by the



observation of Almogi Labin (1982: p. 58), who recorded many juvenile specimens with protoconch. Richter (1976: p. 146, fig. 4) illustrated a 'thin-shelled' protoconch, stating that such specimens collapse regularly when drying, which indeed points to an organic nature.

In several samples of the gravity core studied for the present paper protoconchs are found (Fig. 48H-L), usually as internal moulds. Dissolution of the calcareous protoconch, followed by a threatening dissolution of the organic membrane occasionally progresses into a more apertural part of the shell. In sample Me 25-37 Kg 1 a number of specimens was found in internal mould preservation demonstrating a wrinkled apical portion, followed by an initial part of the teleoconch not demonstrating the usual annulations, but with a more or less irregular cylindrical surface on which frequently fine radial lines are seen (Fig. 48C-G). Obviously in these specimens also the early part of the teleoconch suffered from dissolution and new calcareous material was precipitated on the inner side of the organic tissue. Such a specimen was already illustrated by Tesch (1904: pl. 1 fig. 16 [not pl. 2]), who considered it an anomaly. Van der Spoel & Newman (1990, figs 1c, d) considered the irregular closing a result of 'shell repair after damage'. Shells with these characteristics were introduced as a new species by Di Geronimo (1974a: p. 113, figs 1-2), *Hyalocylis obtusa* (erroneously included in the Limacinidae), which herewith becomes a junior synonym of *H. striata*, to be applied as a forma only. Kunz (1996: pl. 11, figs 4-5) gave SEM images of this feature, indicating them as '*H. striata* Sondertyp'.

Several fossil taxa, namely *Tentaculites cretaceus* Blanckenhorn, 1889, *Praehyalocylis haitensis* Collins, 1934 and *Hyalocylis euphratensis* Avnimelech, 1945 were already synonymized with the present species by Janssen (1999). Both Rosenberg (2009) and CLEAM (2011) list *Creseis rugulosa* Cantraine, 1841 as a synonym of *Hyalocylis striata*. However, Cantraine (1841) based his record on *Odontidium rugulosum* Philippi, 1836, which is a junior synonym of the benthic gastropod *Caecum trachea* Montagu, 1803. As the specimen recorded by Cantraine (from Pliocene deposits of Andona, near Asti, Italy) is characterized by '*sa solidité et par le petit tubercule qui la termine inférieurement*' it is clear that his specimen represents a species of *Caecum* as well.

The taxa *Creseis monotis* Troschel, 1854 and *C. phaeostoma* Troschel, 1854 were listed by van der Spoel (1976: p. 129-129) and by Rosenberg (2009) as junior synonyms of *Hyalocylis striata*. Considering the measurements of the described specimens, of 0.5 and 1 mm respectively, and the absence of *Hyalocylis* larval shell structures, I consider it more probable that they represent very juvenile *Cavolinia*-species. This was also decided for the taxon *Cleodora trifilis* Troschel, 1954 by van der Spoel (1967: p. 132) and Rosenberg (2009), who treated that taxon as a junior synonym of *Cavolinia tridentata*.

This species is present all over the Mediterranean (Meisenheimer, 1905), inclusive of the Adriatic (Steuer, 1911: p. 718), but is clearly more common in the eastern

than in more western parts of the basin (Rampal, 1975: p. 333). Living specimens were observed in the Strait of Messina by Cantraine (1841). Many stations in the eastern Mediterranean sampled by Oberwimmer (1898) yielded dead and living specimens. According to Rampal (2011) this species is very common in the eastern Mediterranean, but less frequent in the western parts. Herman (1971a, b) mentioned the occurrence of this species in the postglacial or interstadial parts of cores in the southern Aegean Sea, the Levantine Basin and the central Tyrrhenian Sea, adding (1981: p. 189) 'this tropical sub-surface water species is much more abundant in the eastern than in the western basins' (of the Mediterranean). Grecchi & Bertolotti (1988) recorded just three specimens (inclusive of one protoconch) from the colder interval of late Pleistocene sediments in core GC-18 (32° 32' 83" N 26° 50' 49" E). Their illustrated protoconch was correctly identified as *H. striata*, which is amazing, as these authors still considered *Creseis chierchiaie* (Boas, 1886) to be an invalid name based on juvenile specimens of *H. striata*, as was erroneously suggested by van der Spoel (1967, fig. 42). But their specimen has not the slightest resemblance with the real *C. chierchiaie*. The authors refer in this context to Menzies (1958) and Almogi-Labin (1982), the latter of which indeed illustrated a true protoconch of *H. striata*, whereas Menzies misidentified so-called 'beaked larvae' as *Creseis chierchiaie* (see below, at the end of the systematical part of the present paper). So, even after more than 20 years van der Spoel's interpretation still caused a mix-up in pteropod literature. Finally, in 1990, van der Spoel & Newman described the real protoconch of *Hyalocylis striata*, pointing also to several earlier illustrations, and admitting that the idea published by van der Spoel (1967) is incorrect. Remarkably enough, they also denied (van der Spoel & Newman: p. 203) the correctness of Richter's (1976) statements, who in my opinion was the first author who solved the *Hyalocylis*-protoconch-problem convincingly. Corselli & Grecchi (1990: p. 96) refer to *Hyalocylis obtusa*, stating that the taxon is exclusively known by the type series of four specimens from bottom sediments, had never been found alive, and was never referred to in later literature.

In gravity core T87/2/20G (Tab. 3a, b) this species is not rare during the middle part of the Eemian interval, absent during the Weichselian, and reoccurring during the Holocene, but with two specimens only. *Hyalocylis striata* is not rare in many of the bottom samples analyzed for this paper and occurs frequently in internal mould preservation.

#### Genus *Styliola* J.E. Gray, 1847

Type species – '*Styliole*' *recta* Blainville, 1827 (by original designation) = *Styliola subula* Quoy & Gaimard, 1827.

#### *Styliola subula* (Quoy & Gaimard, 1827) (Fig. 49A)

*Cleodora subula* Quoy & Gaimard, 1827: p. 233, pl. 8D, figs 1-3.



*Creseis spinifera* Rang, 1828: p. 313, pl. 17, fig. 1.  
*Creseis subula* Quoy et Gaimard – Rang, 1828: p. 314, pl. 18, fig. 1.  
*Cleodora subulata* [sic] Quoy & Gaimard, 1832: p. 382, pl. 27, figs 14-16.  
*Cleodora subulata*, Quoy et Gaim. – Vérany, 1853: p. 380.  
*Styliola subula* Quoy et Gaimard – Menzies, 1958: p. 387, fig. 4a-e.  
*Clio* (*Styliola*) *subula* Gray – Oberwimmer, 1898: p. 590 (non Gray).  
*Styliola subula* Quoy et Gaimard – van Straaten, 1966: p. 431.  
*Styliola subula* (Quoy & Gaimard, 1827) – van der Spoel, 196, 7p. 63, figs 43-45.  
*Styliola subula* (Quoy et Gaimard) – Blanc-Vernet et al., 1969: p. 220.  
*Styliola subula* (Quoy et Gaimard) – Pastouret, 1970: p. 238, pl. 2, fig. 4.  
*Styliola subula* (Quoy e Gaimard) – Di Geronimo, 1970: p. 81, pl. 3, fig. 7; pl. 5, fig. 2a, b.  
*Styliola subula* (Quoy & Gaimard) – Colantoni et al., 1970: p. 179, pl. 24, fig. 10.  
*Styliola subula* Quoy & Gaimard – Herman, 1971a: p. 617-619.  
*Styliola subula* – Herman, 1971b: p. 475ff.  
*Styliola subula* (Quoy-Gaymard) [sic] – Froget & Pastouret, 1972: p. 612ff.  
*Styliola subula* Quoy et Gaimard – Vatova, 1974: p. 108.  
*Styliola subula* (Quoy and Gaimard, 1827) – Almogi-Labin & Reiss, 1977: p. 15, pl. 9, figs 4, 5.  
*Styliola subula* (Quoy and Gaimard) – Bé & Gilmer, 1977: p. 763, fig. 11; pl. 5, figs 10a-d.  
*Styliola subula* – Herman, 1981: p. 190.  
*Styliola subula* (Quoy and Gaimard) – Buccheri, 1984: p. 80, pl. 1, fig. 8.  
*Styliola subula* (Quoy & Gaimard) – Buccheri & di Stefano, 1984: p. 182, pl. 1, fig. 4.  
*Styliola subula* (Quoy & Gaimard, 1827) – Grecchi & Bertolotti, 1988: p. 106, pl. 1, fig. 9.  
*Styliola subula* (Quoy & Gaimard, 1827) – Biekart, 1989: p. 280ff, pl. 2, fig. 4a, b.  
*Styliola subula* (Quoy & Gaimard, 1827) – Janssen, 1999: p. 18, fig. 3; pl. 3, figs 7-9 (with neotype designation).  
*Styliola subula* (Quoy & Gaimard, 1827) – Gofas et al., 2001: p. 200.  
*Styliola subula* (Quoy & Gaimard, 1827) – Rosenberg, 2009, Malacolog website.  
*Styliola subula* (Quoy & Gaimard, 1827) – WoRMS website, 2011.  
*Styliola subula* (Quoy & Gaimard 1827) – CLEMAM website, 2011.

## Description

Van der Spoel (1967), Bé & Gilmer (1977), Janssen (1999).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 526/many; Me25-11 Kg1, SMF 332868/8; Me25-12

Kg2, SMF 332877/8; Me25-13 Kg1, SMF 332891/50; Me25-13 Kg2, SMF 332907/68; Me25-13 Ku, SMF 332913/1; Me25-15 Kg1, SMF 332928/18; Me25-15 Kg2, SMF 332947/36; Me25-15 Ku, SMF 332965/6; Me25-16 Kg1, SMF 332985/51; Me25-16 Kg2, SMF 333008/50; Me25-17 Kg1, SMF 333034/80; Me25-17 Kg2, SMF 333054/62; Me25-18 Kg1, SMF 333072/24; Me25-18 Kg2, SMF 333087/33; Me25-19 Kg1, SMF 333102/38; Me25-19 Kg2, SMF 333121/125; Me25-20 Kg1, SMF 333141/32; Me25-20 Kg2, SMF 333161/23; Me25-20 Ku, SMF 333182/41; Me25-21 Kg1, SMF 333202/40; Me25-21 Kg2, SMF 333223/26; Me25-22 Kg2, SMF 333242/42; Me25-23 Kg1, SMF 333265/53; Me25-23 Kg2, SMF 333284/54; Me25-23 Ku, SMF 333301/64; Me25-24 Kg1, SMF 333318/33; Me25-24 Kg2, SMF 333335/70; Me25-37 Kg1, RGM 541 623/1820; Me25-37 Ku, SMF 333363/62; Me25-38 Kg1, SMF 333381/39; Me25-38 Ku, SMF 333395/9; Me25-39 Kg1, SMF 333413/44; Me25-39 Kg2, SMF 333431/45.

Gravity core T87/2/20G (Eemian), sample 2.21-2.22 m, RGM 569 213/1; 2.18-2.19 m, RGM 569 230/5, RGM 569 230a/1 (**Fig. 49A**); 2.16-2.17 m, RGM 569 254i/5; 1.72-1.73 m, RGM 569 305f/4.

Gravity core T87/2/20G (Weichselian), sample 1.43-1.44 m, RGM 569 332f/2; 1.13-1.14 m, RGM 569 335b/1.

Gravity core T87/2/20G (Holocene), sample 0.17-0.18 m, RGM 569 373h/1.

Bologna samples: CJ 72 III-20, RGM 570 412/many juveniles; CJ 72 III-21, RGM 570 450/many; CJ 72 III-21 (bottom), RGM 570 752/many juveniles; CJ 72 III-22, MZB (ex RGM 570 648)/many; CJ 72 III-25 (top), RGM 570 537/many; CJ 72 III-27 (centre), RGM 570 697/24 juveniles; CR 20, RGM 570 393/many; CR 31, RGM 570 473/many; CR 33, MZB (ex RGM 569 795)/many; CR 34, RGM 570 676/many; CR 39, RGM 570 618/many; CR 42, RGM 570 364/many; CR 68, RGM 570 726/many; CR 70, RGM 570 565/many; J 73-29, RGM 570 433/3 juveniles; J 74-9, RGM 570 501/many, RGM 570 502/many protoconchs; J 74-12, RGM 569 825/many; T74-65-1, RGM 570 951/many; T74-65-2, RGM 570 893/many; T74-65-9, RGM 570 932/11; T74-65-10, RGM 570 864/many.

## Discussion

The fossil taxa *Styliola sulcifera* Gabb, 1873, *Styliola rangiana* Tate, 1887 and *Clio* (*Styliola*) *lamberti* Checchia-Rispoli, 1921 were synonymized with the present species by Janssen (1990, 1999). Because of difficult interpretation of the original description of *S. subula* and the subsequent confusion that arose between the taxa *Cleodora subula* Quoy & Gaimard and *Creseis spinifera* Rang a neotype was designated (Janssen, 1999) to end nomenclatural uncertainty.

The CLEMAM website claims *Styliola recta* J.E. Gray, 1850 to be a synonym of the present species. Gray, however, referred to '*Styliola recta*' in de Blainville (1827), a taxon that was also considered to be a synonym of *Styliola subula* by Pelseneer (1888: p. 57), van der Spoel (1967: p. 63, with a query) and Rosenberg (2009). But from the description and the list of synonyms given by



Gray, it is clear that he considered *Styliola recta* a junior synonym of *Creseis acicula* (Rang, 1828) (misspelled as 'aciculata') and *C. clava* (Rang, 1828). As *Styliola recta* de Blainville was published without description or illustration I consider it a *nomen dubium*, certainly not to be applied as a junior synonym of either *Styliola subula* or *Creseis acicula/clava*.

Cantraine (1841) reported this species to be common in the Strait of Messina and recorded it as a fossil from the subapenninian hills and the region of Siena (Italy). Oberwimmer (1898) recorded *Styliola subula* in bottom samples from many stations in the eastern Mediterranean and the Adriatic Sea. Living specimens were encountered at 10 stations in the Ionian Sea and the Levantine Basin. Herman (1971a, b; 1981) found this species to be a common occurrence in the postglacial parts of cores in the southern Aegean, the Ionian and the central Tyrrhenian seas, and in the Levantine Basin. Vatova (1974) found this species to be very common in four bottom samples from the Ionian Sea. Almogi-Labin & Reiss (1977: p. 16) recorded this species from sediment samples taken along the coast of Israel in abundances between 8 and 16% of the entire pteropod assemblage, as well as, in somewhat lower concentrations, in two cores from the same area. Rampal (2011) referred to this species as very common in the southwestern and eastern Mediterranean.

*Styliola subula* is a frequently occurring component in many of the bottom samples analyzed for this paper, sometimes found in hundreds of specimens: as an example, in sample Me25-37 Kg1 (RGM 541 623) no less than 1820 specimens were counted. In gravity core T87/2/20G, on the contrary, this species is remarkably rare. It occurs in just three samples of the Eemian interval, and always in very low numbers. It was only found in two of the Weichselian samples (1 or 2 specimens only) and even in the Holocene interval just one specimen was present.

Family Cuvierinidae van der Spoel, 1967

Genus *Cuvierina* Boas, 1886

Type species – *Cuvierina columnella* (Rg.) (by monotypy) (Recent).

Subgenus *Urceolarica* A.W. Janssen, 2006

Type species – *Cuvierina urceolaris* Mörch, 1850 (by original designation) (Recent)

*Cuvierina (Urceolarica) cancapae* A.W. Janssen, 2005 (Fig. 13A-C)

non *Cuvierina* cf. *C. columnella* (Rang, 1827) – Grecchi & Bertolotti, 1988: p. 110, pl. 1, fig. 11 (= Genus *Clionidarum* sp. 4; see below).

? *Cuvierina columnella* (Rg.) – Boas, 1886: p. 132 (partim), pl. 6, figs 950-p (non Rang).

*Cuvierina spoeli* Rampal, 2002: p. 214 (partim, non fig. 1Cs = *Cuvierina columnella*, includes *C. atlantica* and *C. columnella*).

*Cuvierina columella* [sic] (Rang, 1827) – Rolán et al., 2005: p. 224, fig. 1035.

*Cuvierina (Urceolaria) cancapae* Janssen, 2005: p. 52, figs 21-23.

## Description

See Janssen (2005).

## Material examined

MEDITS; Sta. 102, trawl, 35° 59.06' N 14° 10.86' E, 205 m, vi.2004; leg. M. Dimech, 1 specimen (Fig. 13A-C), C. Mifsud collection.

## Discussion

The occurrence of this species, found in a bottom sample from SW of the Maltese archipelago is very surprising. Specimens of *Cuvierina* are sometimes recorded from the western Mediterranean, and were invariably considered to be indicators of Atlantic water masses. Considering the distribution of *Cuvierina* species in the Atlantic (Janssen, 2005, fig. 35) especially the species *C. atlantica* Bé, MacClintock & Currie, 1972 might be expected to penetrate into the Mediterranean through the Strait of Gibraltar. The second Atlantic species, *C. cancapae* occurs only much further south, not in the neighbourhood of Gibraltar. By the presence of clear microornament and its measurements, however, the single

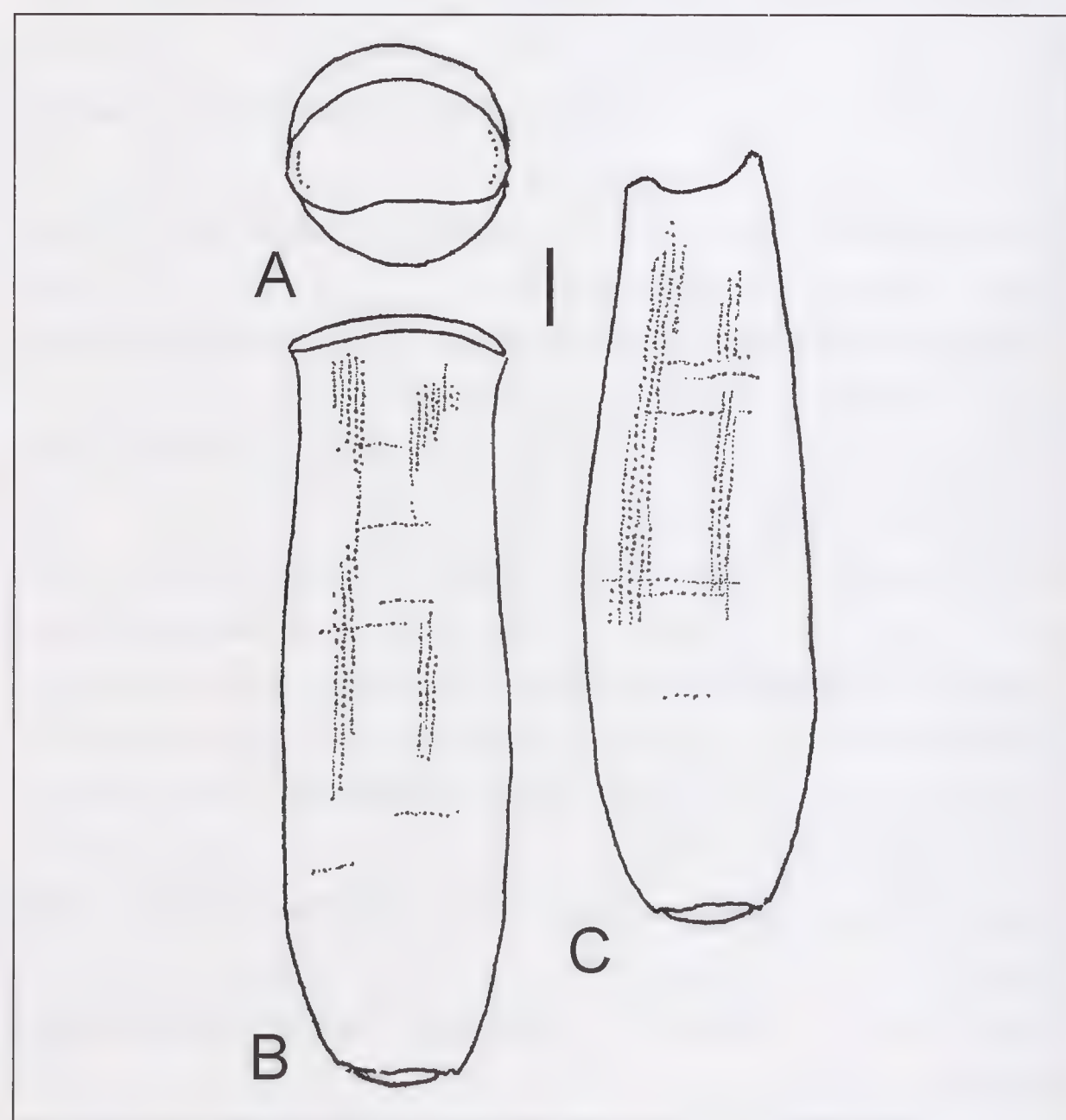


Fig. 13. A-C. *Cuvierina (Urceolarica) cancapae* Janssen; 2005 (microornament schematically indicated); MEDITS; Sta. 102, trawl, 35° 59.06' N 14° 10.86' E, water depth 205 m, April 2004. Leg. M. Dimech, coll. C. Mifsud. A. Apertural view. B. Ventral view. C. Left lateral view. Bar length is 1 mm.

Fig. 13. A-C. *Cuvierina (Urceolarica) cancapae* Janssen; 2005 (microscultura raffigurata in maniera schematica); MEDITS; Stazione 102, retinata, 35° 59,06' N 14° 10,86' E, profondità 205 m, Aprile 2004. Leg. M. Dimech, coll. C. Mifsud. A. Vista aperturale. B. Vista ventrale. C. Vista laterale sinistra. Scala = 1 mm.



specimen in the C. Mifsud collection belongs to the latter species, which therefore must be considered to be transported 'far from home'.

Subgenus *incertae sedis*

*Cuvierina* (s. lat.) sp.  
(Fig. 49B-D)

## Description

Exclusively larval shells were found, characterized by a typical cuvierinid protoconch, as illustrated in Fig. 49B-D. These may be mistaken for larval shells of *Styliola* or *Clio pyramidata*, but are easily distinguished by their rounded apex instead of being pointed.

## Material examined (all protoconchs)

Gravity core T87/2/20G (Eemian), 2.45-2.46 m, RGM 569 098/1; 2.42-2.43 m, RGM 569 110/14; 2.36-2.37 m, RGM 569 132/134, RGM 569 132a-c/1 (Fig. 49B-D); 2.33-2.34 m, RGM 569 154/144; 2.30-2.31 m, RGM 569 172/83; 2.24-2.25 m, RGM 569 192/80; 2.21-2.22 m, RGM 569 214/57; 2.18-2.19 m, RGM 569 231/13; 2.16-2.17 m, RGM 569 254j/16; 2.14-2.15 m, RGM 569 258/5.

## Discussion

Juvenile *Cuvierina* specimens cannot (yet?) be identified to species level. Several authors refer to the presence of *Cuvierina* in the western parts of the Mediterranean, usually indicated as *Cuvierina columnella*. In most cases, however, this may be supposed to be *C. atlantica* Bé, MacClintock & Currie, 1972 in reality, as that is the only Atlantic cuvierinid living in the neighbourhood of Gibraltar (Janssen, 2005, fig. 35).

Specimens from cores and sediment samples taken along the Israelian coast by Almogi-Labin & Reiss (1977: p. 12, pl. 4, fig. 11; pl. 5, figs 1, 3), as well as from the Gulf of Elat, identified as *Cuvierina* cf. *C. columnella* (Rang, 1827) forma *urceolaris* (Mörch 1850) are no pteropods but Scaphopoda, belonging to the family Siphonodentaliidae Simroth, 1894.

Herman (1981: p. 189) referred to '*Cuvierina columnella*' as an indicator of Atlantic water, a tropical species present at very low frequencies near the Strait of Gibraltar and the Alboran Sea. She did not record *Cuvierina* from her cores. Corselli & Grecchi (1990) refer to records in Rampal (1975) of '*Cuvierina columnella*' in the western Mediterranean. Similarly, Rampal (2011) mentions *Cuvierina columnella* as very rare in the Alboran Sea.

A larval specimen distinctly belonging to *Cuvierina* was described as a new species, *Styliola sinecosta* Wells, 1974. Rosenberg (2009) suggests that this name might be a senior synonym of *Cuvierina cancapae* Janssen, 2005. Considering its type locality, W of Barbados, and the distribution of *Cuvierina* species in that area (Janssen, 2005, fig. 35), it could just as well be a juvenile of *C. at-*

*lantica*. A similar problem is formed by the taxon *Creseis caliciformis* Meisenheimer, 1905, which also represents a juvenile *Cuvierina*. Its type locality, however (26° 4' S 93° 44' E) is in an area from which only *C. columnella* is known. Therefore Rosenberg (2009) most probably is right in synonymizing it with that species.

In the present material juvenile *Cuvierina* specimens were only found in the gravity core and exclusively in the middle part of the Eemian, occurring sometimes in rather large numbers, counting up to no less than 550 specimens per 1 cm sample interval, demonstrating a clear preference for somewhat warmer water, and the presence of sound, reproducing populations at that time.

Family Cliidae Jeffreys, 1869

Genus *Clio* Linné, 1767

Type species – '*Clio pyramidata*' (by subsequent designation, J.E. Gray, 1847: p. 203) (Recent).

Note – Subgeneric names are sometimes applied to species of *Clio*, but for many taxa, especially those from the fossil record, this is not (yet) possible, as the morphology of the larval shells is insufficiently known. A reliable subdivision of the genus *Clio* will only be possible when the evolutionary developments will be better understood. The genus is known since the late Eocene by an unidentified species from S. Australia (Janssen, 1990: p. 40, pl. 6, figs 11-12). Also DNA sequencing of the living representatives may shed light on their mutual relationship.

Subgenus *Balantium* Children, 1823

Type species – '*Balantium recurvum*' (by original designation, Children, 1823: p. 220) = *Clio* (*Balantium*) *recurva* (Children, 1823) (Recent).

*Clio* (*Balantium*) *recurva* (Children, 1823)

*Balantium recurvum* Children, 1823: p. 220 (footnote), pl. 7, fig. 107.

*Clio recurva* (Children [sic], 1823 – van der Spoel, 1967: p. 76, figs 72-73 (with extensive synonymy).

*Clio balantium* (Rang) – Bé & Gilmer, 1977: p. 781, fig. 25, pl. 6, fig. 18a-d.

*Clio balantium* (Rang, 1834) – Rampal, 1979: p. 149, fig. 1a.

*Clio recurva* – Rampal, 1996: p. 178, pl. 1, figs K, K'; pl. 2, figs Cr.

## Description

See van der Spoel (1967) and references therein; Bé & Gilmer (1977).

## Discussion

The only Mediterranean record of this species is by Rampal (1979, 1996a), who isolated a single specimen



from bottom sediments in the southern Tyrrhenian Sea, where it was found co-occurring with numerous *Cavolinia uncinata* and *Diacria trispinosa*, pointing to a deposit “d’une passée chaude correspondant probablement à l’un des derniers ‘optima climatiques’ qui ont précédé la période de sédimentation actuelle” [“of a former warm period probably corresponding to one of the last ‘climatic optima’ that preceded the actual sedimentation period”]

Subgenus *Bellardiclio* Janssen, 2004

Type species – *Clio* (*Bellardiclio*) *cuspidata* (Bosc, 1802) (by original designation) (Recent).

*Clio* (*Bellardiclio*) *cuspidata* (Bosc, 1802)  
(Figs 14A-F, 21A-C, 49E-I)

- Hyalæa cuspidata* Bosc, 1802: p. 241, pl. 9, figs 5-7.  
*Cleodora Lessonii* Rang & Férussac, 1829: p. 261 (*nomen nudum*).  
*Cleodora cuspidata* – delle Chiaje, 1830: pl. 83, figs 9-11.  
*Cleodora Lessonii*, Rang – Lesson, 1830: p. 247 (pl. 10, fig. 1; not seen).  
 ? *Cleodora quadrispinosa*, Lesson, 1830: p. 248.  
*Hyalæa cuspidata*. Bosc – Cantraine, 1841: p. 29, figs 8, 8a.  
*Cleodora cuspidata*, Quoy et Gaimard [sic] – Souleyet in Rang & Souleyet, 1852: p. 48, pl. 5, figs 4, 5; pl. 10, fig. 3.  
*Cleodora cuspidata*, Quoy & Gaimard – Vérany, 1853: p. 380 (non Quoy & Gaimard).  
*Cleodora cuspidata* Quoy e Gaym. [sic] – Seguenza, 1867: p. 10, pl. 1, fig. 10a, b.  
*Cleodora cuspidata* Lamk. [sic] (*Hyalæa*) – Seguenza, 1880: p. 276.  
*Clio* (*Clio*) *cuspidata* Pels. – Oberwimmer, 1898: p. 590 (non Pelseneer).  
*Euclio cuspidata* (Bosc) – Menzies, 1958: p. 383, fig. 2a, b.  
*Euclio cuspidata* (Bosc) – van Straaten, 1966: p. 431.  
*Clio cuspidata* (Bosc, 1802) – van der Spoel, 1967: p. 73, figs 64-67 (with extensive synonymy).  
*Euclio cuspidata* (Bosc) – Blanc-Vernet et al., 1969: p. 220.  
*Clio cuspidata* (Bosc) – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280ff.  
*Euclio cuspidata* (Bosc) – Pastouret, 1970: p. 238, pl. 2, fig. 5.  
*Euclio cuspidata* (Bosc) – Di Geronimo, 1970: p. 74, pl. 3, fig. 9; pl. 5, fig. 1a-d.  
*Clio cuspidata* (Bosc) – Colantoni et al., 1970: p. 181, pl. 25, fig. 1a-c; pl. 26, figs 1, 2.  
*Clio cuspidata* (Bosc) – Herman, 1971a: p. 614, 618.  
*Clio cuspidata* – Herman, 1971b: p. 475ff.  
*Euclio cuspidata* (Bosc) – Froget & Pastouret, 1972: p. 612ff.  
*Euclio cuspidata* (Bosc) – Vatova, 1974: p. 108.  
*Clio cuspidata* (Bosc) – Bé & Gilmer, 1977: p. 781, fig. 24; pl. 5, figs 15a-d.  
*Clio cuspidata* (Bosc, 1802) – Almogi-Labin & Reiss, 1977: p. 8, pl. 1, figs 5-8.

- Clio cuspidata* (Bosc) – Buccheri, 1978: p. 134, pl. 2, fig. 7.  
*Clio cuspidata* (Bosc) – Buccheri et al., 1980: p. 99, pl. 1, fig. 10.  
*Clio cuspidata* (Bosc) – Herman, 1981: p. 178ff.  
*Clio cuspidata* – Torelli & Buccheri, 1981: p. 178.  
*Clio cuspidata* (Bosc) – Buccheri & Torelli, 1981: p. 78.  
*Clio cuspidata* – Herman, 1981: p. 189.  
 non *Clio cuspidata* (Bosc) – Grecchi, 1982: p. 721, pl. 53, figs 1, 2 (non Bosc = *C. braidensis*?).  
*Clio cuspidata* (Bosc) – Torelli & Buccheri, 1983: p. 160ff, pl. 2, fig. 4.  
*Clio cuspidata* (Bosc, 1802) – Grecchi, 1984: p. 17, pl. 1, fig. 7.  
*Clio cuspidata* (Bosc) – Buccheri, 1984: p. 80.  
*Clio cuspidata* (Bosc) – Buccheri, 1985: p. 119.  
*Clio cuspidata* (Bosc, 1802) – Grecchi & Bertolotti, 1988: p. 109, pl. 1, fig. 6.  
*Clio cuspidata* – Biekart, 1989: p. 208ff, pl. 2, fig. 3.  
*Clio cuspidata* (Bosc) – Buccheri & Bertoldo, 1992: p. 497, 498.  
*Clio cuspidata* (Bosc, 1802) – Kunz, [1996]: p. 105, pl. 14, figs 1-4.  
*Clio cuspidata* (Bosc, 1802) – Gofas et al., 2001: p. 200.  
*Clio* (*Bellardiclio*) *cuspidata* (Bosc, 1802) – Janssen, 2004: p. 114, pl. 3, figs 3a, b, 4a, b.  
*Clio cuspidata* (Bosc, 1802) – Rosenberg, 2009, Malacolog website.  
*Clio cuspidata* (Bosc, 1802) – WoRMS website, 2011.  
*Clio cuspidata* (Bosc 1802) – CLEMAM website, 2011.  
*Clio cuspidata* (Bosc, 1802) – ETI website, 2011.

## Description

Di Geronimo (1970), Bé & Gilmer (1977). A semiadult specimen is illustrated in Fig. 14A-F, compared to *Clio oblonga* (Fig. 15A-F); a juvenile specimen is illustrated in Fig. 21A-C, for a comparison with *Clio polita*. The curiously reticulated apical spine of the protoconch is illustrated in Fig. 49F and I.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 528/26 juveniles; Me25-13 Kg1, SMF 332892/2; Me25-15 Kg1, SMF 332929/6; Me25-15 Kg2, SMF 332948/1 protoconch; Me25-16 Kg2, SMF 333009/5, 1 protoconch; Me25-17 Kg1, SMF 333035/5; Me25-17 Kg2, SMF 333055/4; Me25-19 Kg1, RGM 569 499/2, SMF 333103/11; Me25-19 Kg2, SMF 333122/3, 1 protoconch; Me25-20 Kg2, SMF 333162/2; Me25-20 Ku, SMF 333183/1 protoconch; Me25-21 Kg1, SMF 333203/1 protoconch; Me25-22 Kg2, SMF 333243/2; Me25-22 Ku, SMF 333250/2; Me25-23 Kg1, SMF 333266/8, 1 protoconch; Me25-23 Kg2, SMF 333285/2; Me25-23 Ku, SMF 333302/1; Me25-24 Ku, SMF 333344/1; Me25-37 Kg1, RGM 541 624/ 30, 35 fragments; Me25-37 Ku, SMF 333364/8; Me25-38 Kg1, SMF 333382/5; Me25-38 Ku, SMF 333396/14; Me25-39 Kg1, SMF 333414/1; Me25-39 Kg2, SMF 333432/1 protoconch; Me51/3-562, DCS RGA510/1.  
 Gravity core T87/2/20G (Eemian), sample 2.47-2.48 m,



RGM 569 095h/1 protoconch; 2.45-2.46 m, RGM 569 100e/1 protoconch; 2.42-2.43 m, RGM 569 119d/2 protoconchs; 2.36-2.37 m, RGM 569 133/3 protoconchs; 2.33-2.34 m, RGM 569 155/4 protoconchs, RGM 569 155a/1 protoconch (Fig. 49E-G); 2.30-2.31 m, RGM 569 181f/5 protoconchs; 2.24-2.25 m, RGM 569 202d/2 protoconchs; 2.21-2.22 m, RGM 569 215/5 protoconchs, RGM 569 215a/1 protoconch (Fig. 49H, I); 2.16-2.17 m, RGM 569 254k/1 fragment; 2.03-2.04 m, RGM 569 284e/2; 1.97-1.98 m, RGM 569 292i/3.

Gravity core T87/2/20G (Weichselian), sample 1.53-1.54 m, RGM 569 330c/1; 1.43-1.44 m, RGM 569 332g/1; 0.72-0.73 m, RGM 569 347c/1.

Bologna samples: CJ 72 III-20, RGM 570 413/9 protoconchs; CJ 72 III-21, RGM 570 451/4 protoconchs, 10 fragments, RGM 570 966/1 juvenile (Fig. 14A-F); CJ 72 III-21 (bottom), RGM 570 753/11 protoconchs; CJ 72 III-22, MZB (ex RGM 570 649)/19 protoconchs; CJ 72 III-23, RGM 570 422/9 fragments; CJ 72 III-25 (top), RGM 570 538/7 protoconchs; CJ 72 III-27 (centre), RGM 570 698/1 protoconch; CR 20, RGM 570 394/c. 30 protoconchs; CR 31, RGM 570 474/1, 10 protoconchs, 1 fragment; CR 33, MZB (ex RGM 569 796)/17 protoconchs; CR 34, RGM 570 677/11 protoconchs; CR 39, RGM 570 619/many protoconchs, 6 fragments, RGM 570 848/1 (Fig. 21); CR 42, RGM 570 363/many juveniles; CR 68, RGM 570 727/many juveniles; CR 70, RGM 570 567/1 fragment, 15 protoconchs; J 73-29, RGM 570 434/2 fragments; J 74-9, RGM 570 503/11, 2 fragments, RGM 570 504/many protoconchs; J 74-12, RGM 569 826/1, RGM 569 827/16 protoconchs; T74-65-1, RGM 570 952/35 protoconchs; T74-65-2, RGM 570 894/19 protoconchs; T74-65-10, RGM 570 865/8 fragments.

## Discussion

Van der Spoel (1967: p. 73), and, apparently based on that reference, the websites Rosenberg (2009), ETI (2011) and CLEMAM (2011) all considered the taxon *Hyalea tricuspidata* Bowdich (1822: pl. 5, fig. 1) (by all four authors incorrectly cited as 1820) as a junior synonym of *Clio cuspidata*. This is, however, erroneous, as Bowdich's illustration distinctly represents a specimen of a specifically unidentifiable *Cavolinia* sp. What Bernard (1955: p. 7) had before him, indicated as *Cleodora tricuspidata*, has to remain unknown as a description and/or an illustration was not given.

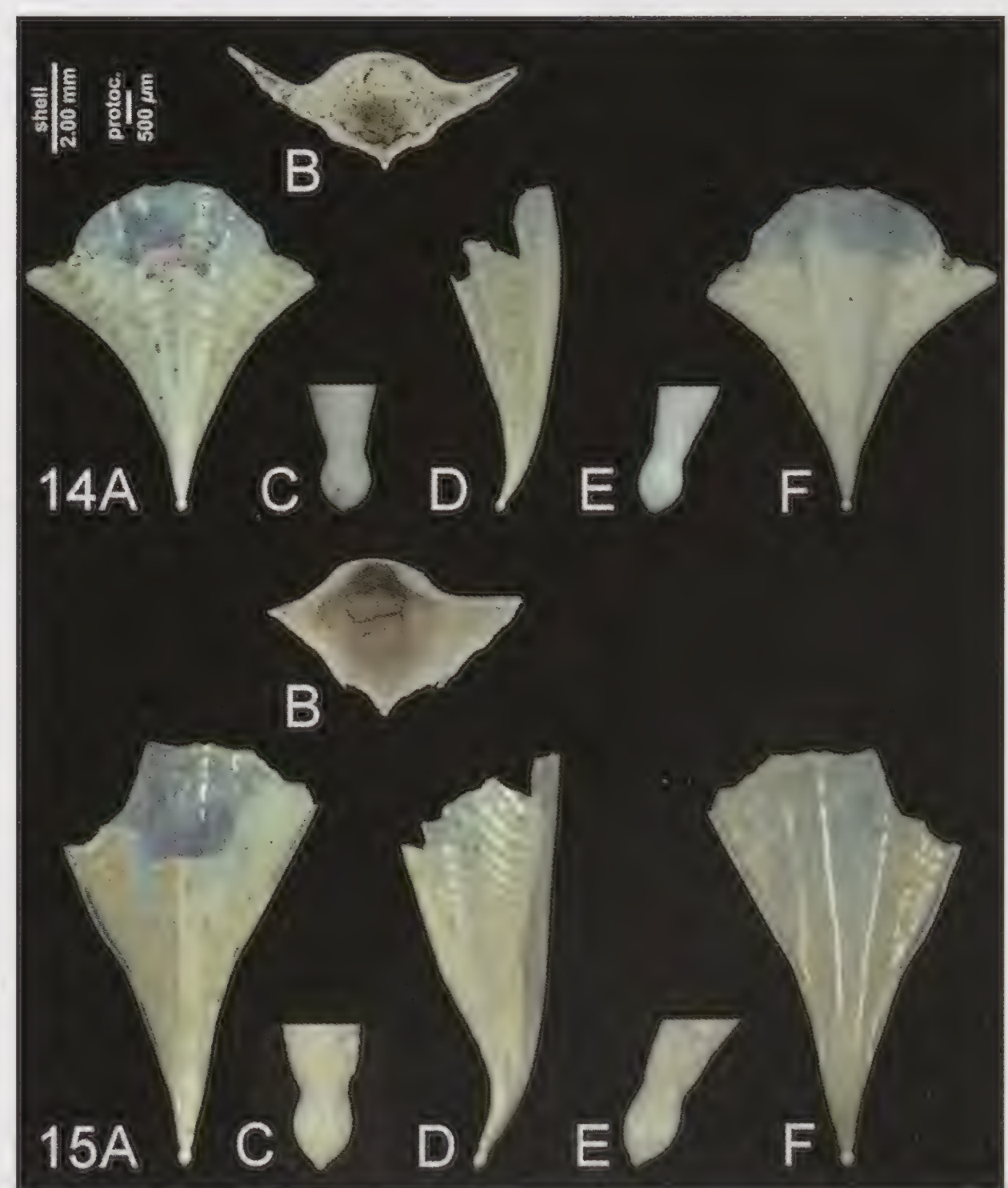
Oberwimmer (1898) recorded *C. cuspidata* from bottom samples from the eastern Mediterranean and the Adriatic, but just a few living specimens, only from the Adriatic. Herman (1971a, b; 1981) found this species to be a common occurrence in postglacial and interstadial sediments in cores from the Levantine Basin, the Ionian and central Tyrrhenian seas, as well as from the Algero-Provençal Sea. She characterized *Clio cuspidata* as 'a bathypelagic species present in all basins (of the Mediterranean) at low frequencies, reaching peak abundancies in the cool Alboran, Liguria and Provençal basins'. Vatova (1974) recorded this species from four bottom samples in the Ionian Sea, in two of these even as a common species.

Almogi-Labin & Reiss (1977), mentioned specimens from sediment samples and cores from along the Israeli coast, illustrated details of the embryonic shell, among which also a detailed picture of the protoconch's apical spine, illustrating the same reticulate structure as found in the present material. Also Kunz (1996: pl. 14, fig. 4) illustrated this feature nicely. Grecchi & Bertolotti (1988) recorded a restricted number of specimens, predominantly from the warmer intervals of the middle Pleistocene-Holocene of core GC-18 (32° 32' 83" N 26° 50' 49" E). According to Rampal (2011) *Clio cuspidata* occurs rather frequently, especially so in the western basin.

In gravity core T87/2/20G *Clio cuspidata* is present in 11 samples of the Eemian interval, but in few specimens only. During the Weichselian it was found in three samples (1 specimen each); above sample 0.72-0.73 m the species disappears completely. In many of the other bottom samples this species is present, but always in restricted numbers and because of its extreme fragility usually as fragments or as isolated protoconchs.

### *Clio (Bellardiclio) oblonga* Rampal, 1996a (Fig. 15A-F)

*Clio oblonga* Rampal, 1996a: p. 176, pl. 1A-I; pl. 2Co.



**Figs. 14, 15.** *Clio* spp. **Fig. 14A-F.** *Clio (Bellardiclio) cuspidata* (Bosc, 1802), Ionian Sea, sample CJ72III-21, RGM 570 966. **Fig. 15A-F.** *Clio (Bellardiclio) oblonga* Rampal, 1996, paratype, Tyrrhenian Sea, RGM 570 965. **A.** Dorsal views. **B.** Apertural views. **C.** Protoconch, dorsal views. **D.** Right lateral views. **E.** Protoconch, right lateral views. **F.** Ventral views.

**Figs. 14, 15.** *Clio* spp. **Fig. 14A-F.** *Clio (Bellardiclio) cuspidata* (Bosc, 1802), mar Ionio, campione CJ72III-21, RGM 570 966. **Fig. 15A-F.** *Clio (Bellardiclio) oblonga* Rampal, 1996, paratipo, Mar Tirreno, RGM 570 965. **A.** Viste dorsali. **B.** Viste aperturali. **C.** Protoconca, viste dorsali. **D.** Viste laterali destre. **E.** Protoconch, viste laterali destre. **F.** Viste ventrali.



## Description

See Rampal (1996a). This species resembles *Clio cuspidata* closely but differs by a number of characteristics: the shell of *C. cuspidata* is regularly curved dorso-ventrally, whereas in *C. oblonga* only the apical part is bent, in *C. oblonga* the dorso-ventral diameter is larger than in *C. cuspidata*, in *C. oblonga* the apertural and lateral spines are reduced (which may partly be a preservation artefact), and in *C. oblonga* the rather coarse transverse ornament is covered with a second order, much finer transverse striation that is absent in *C. cuspidata*. Its protoconch reaches slightly larger dimensions (compare Figs 14 and 15).

## Material examined

Three paratypes from the type locality in the Tyrrhenian Sea (39° 36' 0" N 13° 49' 3" E, bottom sample), donated by J. Rampal (June 1996), RGM 396 499/2, RGM 570 965/1 semiadult (Fig. 15A-F).

Bologna samples: T74-55-6, RGM 570 919/1 fragment, 7 protoconchs; T74-65-2, RGM 570 895/2 protoconchs; T74-65-10, RGM 570 866/1; T74-65-10, RGM 570 867/4 juveniles.

## Discussion

As both *Clio cuspidata* and *C. oblonga* occur in the type sample a separation of the two forms seems acceptable. It remains curious that following its first description *C. oblonga* was never recorded again. Also, it has not been possible to recognize the species among the abundant protoconchs and apical fragments found during this study in other samples. But, as a slight difference in protoconch measurements was mentioned by Rampal, a careful morphometric study of many specimens might reveal the presence of *C. oblonga* at other places as well. According to Rampal, it was recorded from post-glacial sediments, in an assemblage also containing many *Diacria trispinosa* and *Cavolinia uncinata*, pointing to a relatively warm period. The occurrence of the last mentioned species is interesting, as it has never been recorded from any other, obviously fossil bottom sample in the eastern basin, only 'subrecent' specimens were found once during the present study, in the easternmost sample (see below).

Few specimens of *Clio oblonga* were recovered from the Bologna samples T74-55 and 65, originating from the Tyrrhenian Sea. In those samples, however, the 'warm species' mentioned by Rampal were absent, whereas the species *Limacina retroversa* was abundantly present in all subsamples yielding *C. oblonga*. This rather indicates cooler circumstances than suggested by Rampal.

Subgenus *Clio* s.str.

*Clio (Clio) pyramidata* Linné, 1767

Note – Although hardly or not recognized previously, the typification of *Clio pyramidata* meets with problems.

Linné (1767) based his record of that taxon on a description and illustration in Browne (1756: p. 386, pl. 43, fig. 1) and that drawing shows a specimen of *Clio*, the regularly triangular shell of which has completely straight sidelines, agreeing more or less with today's interpretation of *C. pyramidata* s. str. and already interpreted as such in Tesch (1913) and later authors. Problematic, however, is the origin of Browne's specimen, which must be supposed to be at or near Jamaica in the Caribbean, an area where specimens of *C. pyramidata* with completely straight sidelines do not occur. All specimens from that area that I have seen invariably belong to what is nowadays indicated as f. *lanceolata*, showing strongly concave sidelines. As Browne's specimen reaches a size over 10 mm it does not represent a juvenile specimen in which the concavity of the sidelines is not yet very clear. A possibility could be that the admittedly rather primitive illustration of Browne's specimen is erroneous. A solution for this problem might be the designation of a neotype (syntypes do not exist: van der Spoel, 1976: p. 190) from the neighbourhoods of Jamaica, which undoubtedly would be a specimen with concave sidelines and consequently f. *lanceolata* (Lesueur, 1813) would fall into the synonymy of *C. pyramidata* s.str. Also, a new name for what is now considered to be *C. pyramidata* f. *pyramidata* would be necessary. Additionally, the introduction of *Hyalea lanceolata* by Lesueur (1813: p. 284, pl. 5, fig. 3A, B) also is not unmistakable: the concave sidelines are not mentioned and the illustrations are so poor in quality that the species is completely irre recognizable. The fact, however, that Lesueur's material was collected in the Mediterranean (Nice) makes it at least probable that he indeed had a specimen of f. *lanceolata* as interpreted nowadays, before him. Likewise, syntypes are not available anymore. For now, I prefer to maintain the usual interpretation of *C. pyramidata* formae, instead of creating an undesirable confusion in these frequently cited taxa.

*Clio (Clio) pyramidata* Linné, 1767 f. *lanceolata*  
(Lesueur, 1813)  
(Figs 16A-D, 17A-F, 49J-L)

*Hyalea lanceolata* Lesueur, 1813: p. 284, pl. 5, fig. 3A, B (mala).

*Cleodora lanceolata* – delle Chiaje, 1830: pl. 83, figs 7-8.

*Hyalæa pyramidata*. Per. [sic] – Cantraine, 1841: p. 30, pl. 1, figs 7, 7a (non fig. 9).

*Cleodora lanceolata*, Les. – Vérany, 1853: p. 380.

*Clio (Clio) pyramidata* L. – Oberwimmer, 1898: p. 590.

*Euclio pyramidata* (Linne) – Menzies, 1958: p. 383, fig. 1a-c.

*Euclio pyramidata* Linné – van Straaten, 1966: p. 431.

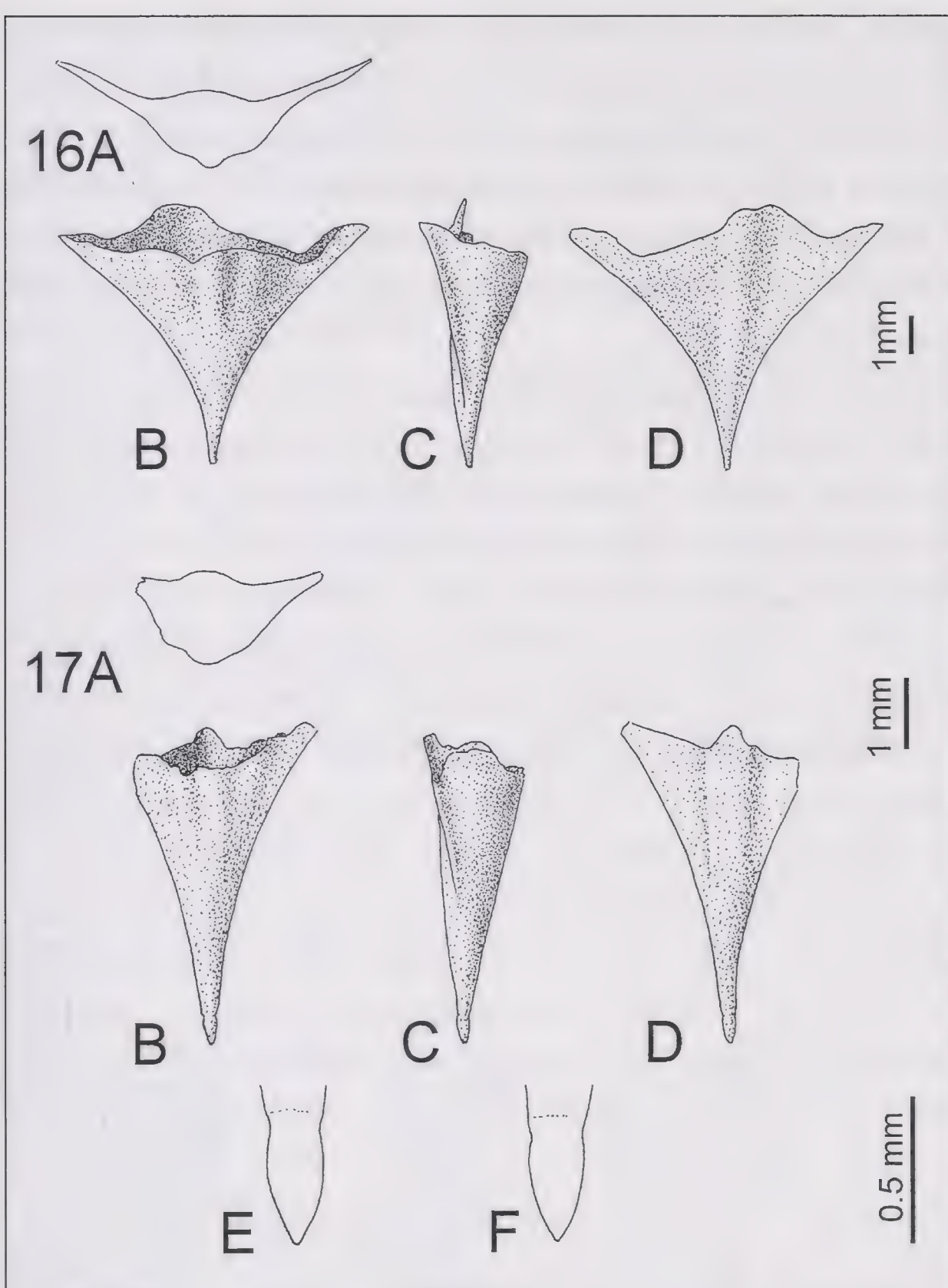
*Clio pyramidata* Linnaeus, 1767 forma *lanceolata* (Lesueur, 1813) – van der Spoel, 1967: p. 68, figs 50-54, 60.

*Euclio pyramidata* (L.) – Blanc-Vernet et al., 1969: p. 220.

*Clio pyramidata* Linné – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280ff.

*Euclio pyramidata* (Linné) – Pastouret, 1970: p. 238, pl. 2, fig. 1; pl. 3, fig. 4.





**Figs 16, 17.** *Clio pyramidata* Linné, 1767 f. *lanceolata* (Lesueur, 1813). Tyrrhenian Sea, sample T74-65-10, RGM 570 869-870. **Fig. 16A-D.** Semiadult specimen. **Fig. 17A-F.** Juvenile specimen. **A.** Apertural views. **B.** Dorsal views. **C.** Left lateral views. **D.** Ventral views. **E.** Protoconch, dorsal view. **F.** Protoconch, left lateral view.

**Figs 16, 17.** *Clio pyramidata* Linné, 1767 f. *lanceolata* (Lesueur, 1813). Mar Tirreno, campione T74-65-10, RGM 570 869-870. **Fig. 16A-D.** Esemplare sub-adulto. **Fig. 17A-F.** Esemplare juvenile. **A.** Viste aperturali. **B.** Viste dorsali. **C.** Viste laterali sinistre. **D.** Viste ventrali. **E.** Protoconca, vista dorsale. **F.** Protoconca, vista laterale sinistra.

*Euclio pyramidata* (Linné) – Di Geronimo, 1970: p. 72, pl. 3, fig. 8; pl. 5, fig. 3a, b.

*Clio pyramidata* L. forma *lata* Boas 1886 – Colantoni et al., 1970: p. 180, pl. 24, fig. 13; pl. 25, figs 2a, c, 3a, c.

*Clio pyramidata* Linné – Herman, 1971a: p. 614, 618, 619.

*Clio pyramidata* – Herman, 1971b: p. 475ff.

*Euclio pyramidata* (Linné) – Froget & Pastouret, 1972: p. 612ff.

*Euclio pyramidata* (Linnaeus) var. *lata* Boas – Vatova, 1974: p. 107, 108.

*Euclio pyramidata* (Linnaeus) var. *angusta* Boas – Vatova, 1974: p. 107, 108.

*Clio pyramidata lanceolata* (Lesueur, 1813) – Rampal, 1975: p. 210ff, fig. 57.

*Clio pyramidata* Linn. 1767 – Nordsieck, 1973: p. 6, fig. 23.

*Clio pyramidata* (Linne, 1767) forma *lanceolata* (Lesueur, 1813) – Almogi-Labin & Reiss, 1977: p. 10, pl. 3, figs 1-2.

*Clio pyramidata lanceolata* – Bé & Gilmer, 1977: p. 766, pl. 7, fig. 21a-c.

*Clio pyramidata* – Herman, 1981: p. 189.

*Clio pyramidata* Linneo, 1767 – Grecchi, 1984: p. 16, pl. 1, fig. 8.

*Clio pyramidata* L. f. *lanceolata* Lesueur – Buccheri, 1984: p. 80, pl. 1, fig. 2a-c.

*Clio pyramidata* Linnaeus, 1767 forma *lanceolata* Lesueur, 1813 – Pafort-van Iersel, [1985]: p. 21.

*Clio pyramidata* – Vergneau-Grazzini et al., 1988: p. 8, pl. 3, figs 16, 17.

*Clio pyramidata* Linneo, 1767 – Grecchi & Bertolotti, 1988: p. 108, pl. 1, fig. 5.

*Clio pyramidata* (Linné, 1767) – Gofas et al., 2001: p. 200.

*Clio pyramidata lanceolata* (Lesueur, 1813) – Rampal, 2002: p. 237, figs 12, 13.

*Clio pyramidata* Linnaeus, 1767 forma *lanceolata* – Pierrot-Bults & van der Spoel, 2003: p. 298, fig. 1 (distribution only).

*Clio pyramidata lanceolata* Lesueur, 1813 [sic] – WoRMS website, 2011.

*Clio pyramidata* Linnaeus, 1767 forma *lanceolata* (Lesueur, 1813) – ETI website, 2011.

## Description

See van der Spoel (1967), Bé & Gilmer (1977). Characteristic juvenile and subadult specimens of this very abundant form are illustrated in **Figs 16-17**.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 527/many; Me25-11 Kg1, SMF 332869/10; Me25-12 Kg2, SMF 332878/5; Me25-13 Kg1, SMF 332893/37; Me25-13 Kg2, SMF 332908/39; Me25-13 Ku, SMF 332914/10; Me25-15 Kg1, SMF 332930/20; Me25-15 Kg2, SMF 332949/8; Me25-15 Ku, SMF 332966/18; Me25-16 Kg1, SMF 332986/8; Me25-16 Kg2, SMF 333010/26, 12 protoconchs; Me25-17 Kg1, SMF 333036/30; Me25-17 Kg2, SMF 333056/35, 12 protoconchs; Me25-18 Kg2, SMF 333088/3; Me25-19 Kg1, SMF 333104/15; Me25-19 Kg2, SMF 333123/15, 24 protoconchs; Me25-20 Kg1, SMF 333142/14; Me25-20 Kg2, SMF 333163/11; Me25-20 Ku, SMF 333184/34; Me25-21 Kg1, SMF 333204/18; Me25-21 Kg2, SMF 333224/15; Me25-22 Kg2, SMF 333244/25; Me25-22 Ku, SMF 333251/5; Me25-23 Kg1, SMF 333267/18; Me25-23 Kg2, SMF 333286/15; Me25-23 Ku, SMF 333303/33; Me25-24 Kg1, SMF 333319/10; Me25-24 Kg2, SMF 333336/11; Me25-24 Ku, SMF 333345/2; Me25-25 Kg1, SMF 333347/38; Me25-37 Kg1, RGM 541 625/1170; Me25-37 Ku, SMF 333365/46; Me25-38 Kg1, SMF 333383/26; Me25-38 Ku, SMF 333397/23; Me25-39 Kg1, SMF 333415/13; Me25-39 Kg2, SMF 333433/22; Me51/3-562, DCS RGA500/7.

Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 079g/1 (Saalian).

Gravity core T87/2/20G, sample 2.54-2.55 m, RGM 569 092f/1; 2.49-2.50 m, RGM 569 093f/1 protoconch; 2.47-2.48 m, RGM 569 095i/1 protoconch; 2.42-2.43 m, RGM 569 119e/28 protoconchs; 2.36-2.37 m, RGM 569 134/87, RGM 569 134a/1 protoconch (**Fig. 49L**), RGM 569 134b, c/2 protoconch (**Fig. 49J, K**); 2.33-2.34 m, RGM 569 165f/59 protoconchs; 2.30-2.31 m, RGM 569 181g/35 protoconchs; 2.24-2.25 m, RGM 569 202e/32 proto-



conchs; 2.21-2.22 m, RGM 569 225c/23 protoconchs; 2.18-2.19 m, RGM 569 242g/14 protoconchs; 2.16-2.17 m, RGM 569 254l/29 protoconchs; 2.14-2.15 m, RGM 569 266d/6; 2.14-2.15 m, RGM 569 271e/12; 2.03-2.04 m, RGM 569 284f/13; 1.97-1.98 m, RGM 569 292j/3; 1.91-1.92 m, RGM 569 300g/8; 1.79-1.80 m, RGM 569 303d/2; 1.72-1.73 m, RGM 569 305g/5; 1.72-1.73 m, RGM 569 313c/17; 1.68-1.69 m, RGM 569 324c/29; 1.65-1.66 m, RGM 569 326c/11 (Eemian).

Gravity core T87/2/20G, sample 1.48-1.49 m, RGM 569 331f/1; 1.43-1.44 m, RGM 569 332h/1; 1.33-1.34 m, RGM 569 333g/4; 1.23-1.24 m, RGM 569 334d/1; 1.13-1.14 m, RGM 569 335c/1; 1.08-1.09 m, RGM 569 336c/1; 1.03-1.04 m, RGM 569 337d/1; 0.93-0.94 m, RGM 569 340d/3; 0.89-0.90 m, RGM 569 341c/2; 0.87-0.88 m, RGM 569 342d/2; 0.84-0.85 m, RGM 569 343b/1; 0.80-0.81 m, RGM 569 344d/3; 0.77-0.78 m, RGM 569 345c/2; 0.75-0.76 m, RGM 569 346d/3; 0.72-0.73 m, RGM 569 347d/2; 0.70-0.71 m, RGM 569 348c/2; 0.65-0.66 m, RGM 569 349c/2; 0.60-0.61 m, RGM 569 350e/5; 0.55-0.56 m, RGM 569 351c/7; 0.50-0.51 m, RGM 569 352d/15; 0.45-0.46 m, RGM 569 353c/10; 0.40-0.41 m, RGM 569 354c/18; 0.35-0.36 m, RGM 569 355c/5; 0.30-0.31 m, RGM 569 356g/8; 0.25-0.26 m, RGM 569 365e/14 (Weichselian).

Gravity core T87/2/20G, sample 0.22-0.23 m, RGM 569 366h/8; 0.20-0.21 m, RGM 569 367h/3; 0.19-0.20 m, RGM 569 368f/3; 0.18-0.19 m, RGM 569 369i/6; 0.17-0.18 m, RGM 569 373i/3; 0.16-0.17 m, RGM 569 374h/3; 0.14-0.15 m, RGM 569 375i/10; 0.12-0.13 m, RGM 569 383f/20; 0.11-0.12 m, RGM 569 389f/3; 0.095-0.105 m, RGM 569 391f/1 (Holocene).

Bologna samples: CJ 72 III-20, RGM 570 414/many protoconchs; CJ 72 III-21, RGM 570 452/many; CJ 72 III-21 (bottom), RGM 570 754/many juveniles; CJ 72 III-22, MZB (ex RGM 570 650)/6 fragments, MZB (ex RGM 570 651)/many protoconchs; CJ 72 III-23, RGM 570 423/many; CJ 72 III-25 (top), RGM 570 539/many; CJ 72 III-27 (centre), RGM 570 699/many protoconchs, some fragments; CR 20, RGM 570 395/many; CR 31, RGM 570 475/many; CR 33, MZB (ex RGM 569 797)/many; CR 34, RGM 570 678/many; CR 39, RGM 570 620/many; CR 42, RGM 570 365/many; CR 68, RGM 570 728/many juveniles; CR 70, RGM 570 568/many juveniles; J73-6, RGM 569 902/20 fragments; J 73-17, RGM 570 635/15; J 73-29, RGM 570 435/many; J 74-9, RGM 570 505/many, RGM 570 506/many protoconchs; J 74-10, RGM 569 915/30 protoconchs; J 74-12, RGM 569 829/many, RGM 569 830/many (moulds); T74-65-1, RGM 570 953/many (mainly juveniles); T74-65-2, RGM 570 896/many (mainly juveniles); T74-65-9, RGM 570 933/6, 6 fragments; T74-65-10, RGM 570 868/many, RGM 570 869/1 juvenile (**Fig. 16A-D**), RGM 570 870/1 (**Fig. 17A-F**).

## Discussion

CLEMAM (2011) still considers *Clio pyramidata* var. *convexa* Boas, 1886 a synonym of *Clio pyramidata*, but *Clio convexa* was repeatedly accepted as an independent species (Rampal, 2002; Janssen, 2007a, b; Rosenberg,

2009). Rosenberg (2009) and CLEMAM (2011) list *Hydralaea lanceolata* Lesueur, 1813 as a synonym of *C. pyramidata*. In many papers recording Mediterranean occurrences no distinction is made between *Clio pyramidata* s.str. and its formae, therefore some of the following observations of fossil assemblages may refer to f. *tyrrhenica* (see below).

In many bottom sample stations analyzed by Oberwimmer (1898) from the eastern Mediterranean and the Adriatic Sea this species was present, but in only four stations (Ionian Sea and Levantine Basin) living specimens were encountered by him. Herman (1971a, b: p. 618, 619; 1981: p. 193-195) recorded this species from postglacial and interstadial sediments in the Levantine, southern Aegean, Ionian and central Tyrrhenian basins, describing it as 'a bathypelagic species collected in 2000 m deep tows in the Ionian Sea. It is widespread in all basins [of the Mediterranean] reaching highest frequencies in the Alboran and Algerian seas'. Vatova (1974) found this pteropod abundantly in bottom samples from the Ionian Sea. Grecchi & Bertolotti (1988) recorded it in core GC-18 (32° 32' 83" N 26° 50' 49" E), from almost all samples, covering middle Pleistocene-Holocene sediments, both in warmer and colder intervals. Many further authors published similar occurrences in the Mediterranean.

Rampal (2011: p. 372) stated for this species 'very common in the Mediterranean', but added, in a footnote '*Clio pyramidata lanceolata* (Lesueur, 1813) est la sous-espèce du groupe *pyramidata* la plus abondante en Méditerranée' [*Clio pyramidata lanceolata* (Lesueur, 1813) is the most abundant subspecies of the *pyramidata* group in the Mediterranean']. It would be interesting to hear which other 'subspecies' she observed in the Mediterranean basin!

*Clio (Clio) pyramidata* Linné, 1767  
f. *pyramidata* Linné, 1767  
(Fig. 18A-F)

*Clio pyramidata*, Linné, 1767: p. 1094.

*Clio pyramidata* Linnaeus, 1767 forma *pyramidata* Linnaeus, 1767 – van der Spoel, 1967: p. 67, figs 48, 49.

## Description

See van der Spoel (1967).

## Discussion

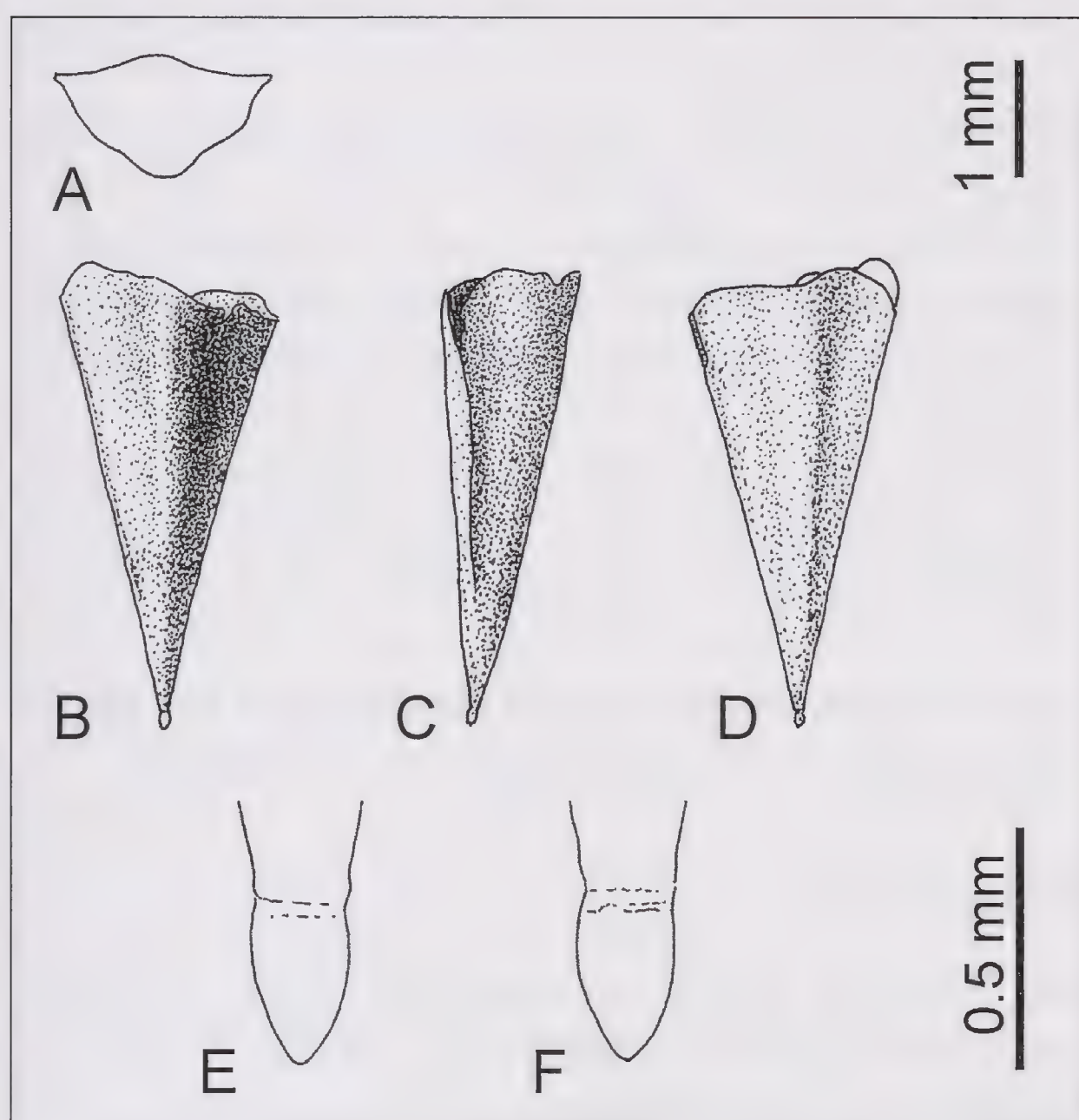
In the currently living fauna the nominal form of *Clio pyramidata*, as commonly interpreted, is restricted to the North Atlantic Ocean, obviously preferring colder water than the much more common and widely distributed f. *lanceolata*, that favors warmer environments, among which is the Mediterranean, where it is one of the most abundantly occurring pteropod species.

Some authors, however, claim to have collected specimens of the f. *pyramidata* in bottom samples or cores from the Mediterranean (Vergnaud Grazzini & Herman



Rosenberg, 1969; Herman, 1971a, b, 1981; Biekart, 1989). This is understandable, as 'cold water assemblages' in which the f. *pyramidata* can be expected are frequently recorded, usually characterized by the abundant occurrence of *Limacina retroversa*. The records of these authors, however, cannot be checked as they are neither described, nor illustrated.

Also some samples in the present material yielded specimens that I initially identified as f. *pyramidata*, in every case indeed accompanied by common *Limacina retroversa*. On closer look, however, this material differs clearly and constantly from f. *pyramidata*. It is described here as a new forma *tyrrhenica* in *C. pyramidata*, see below. The differences with the other formae are given there. The real f. *pyramidata* is illustrated in Fig. 18A-F.



**Fig. 18. A-F.** *Clio pyramidata* Linné, 1767 f. *pyramidata* Linné, 1767. N Atlantic Ocean, E of mid-atlantic ridge, 45°17.7' N 27°50.9' W, JGOFS-IV expedition, sample T90-5b, top 29 cm of box core, water depth 3069 m, June 13, 1990. RGM 570 858, don. G.J. Brummer. **A.** Apertural view. **B.** Dorsal view. **C.** Left lateral view. **D.** Ventral view. **E, F.** Protoconch, ventral and left lateral views.

**Fig. 18. A-F.** *Clio pyramidata* Linné, 1767 f. *pyramidata* Linné, 1767. Oceano Atlantico settentrionale, ad est della dorsale medioatlantica, 45°17,7' N 27°50,9' W, campagna JGOFS-IV, campione T90-5b, 29 cm superiori del box core, profondità 3069 m, 13 Giugno 1990. RGM 570 858, don. G.J. Brummer. **A.** Vista aperturale. **B.** Vista dorsale. **C.** Vista laterale sinistra. **D.** Vista ventrale. **E, F.** Protoconca, vista ventrale e laterale sinistra.

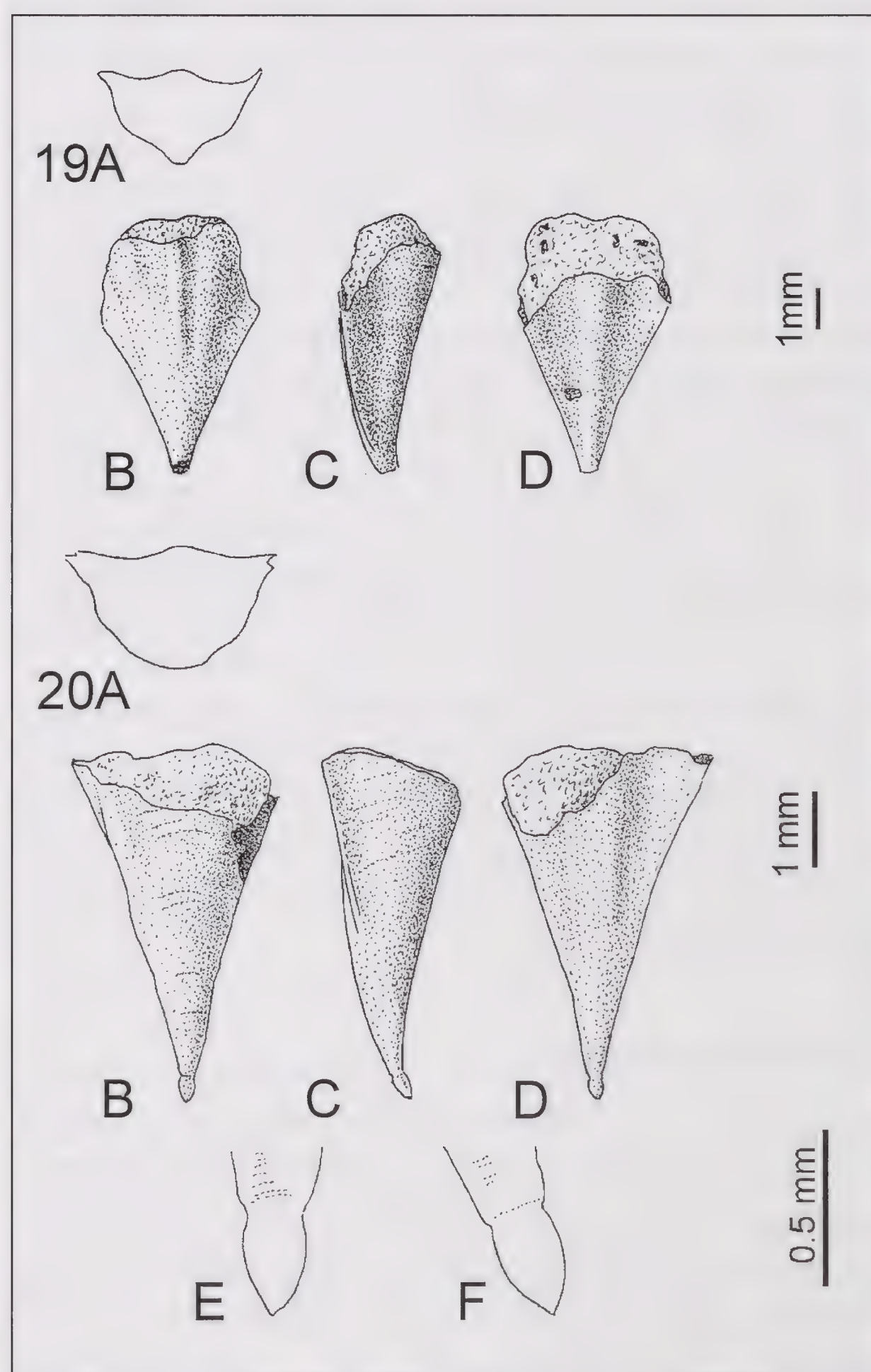
## Discussion

Müller et al. (1975) considered '*Euclio pyramidata*', as occurring in core 3MO67 collected S of Crete, to belong to a group of '*espèces subtropicales tolérantes au froid*', including '*Spiratella inflata*' and *Diacria trispinosa* in the same group. Pafort-van Iersel (1985, Statement 1) was right to criticize this in her PhD. Müller et al. did not distinguish between the two formae of *C. pyramidata*; as a general conclusion their concept is false indeed. It is only the f. *pyramidata*, not the much more common f. *lanceolata*, that is indicative for reduced temperatures.

Van der Spoel (1975) and Diester-Haas & van der Spoel (1978) developed a method to reconstruct seawater palaeotemperatures using measurements of the *Clio pyramidata* protoconch volume. Biekart (1989), following these initiatives, measured protoconch volumes of *Clio pyramidata* and found clearly different mean values (but with large overlaps) for three pteropod zones distinguished by him in core BS 78-12, taken in the Tyrrhenian Sea. He related these values to the results obtained by Diester-Haas & van der Spoel for the North Atlantic, concluding on summer, winter and mean palaeotemperatures for the three pteropod zones. He did not, however, interpret these differences in protoconch morphology to distinguish between the two formae of *C. pyramidata*. Also, his specimens might belong to f. *tyrrhenica*, of course.

*Clio (Clio) pyramidata* Linné, 1767 f. *tyrrhenica* f. nov.  
(Figs 19A-D, 20A-F)

? *Clio pyramidata* f. *pyramidata* Linné – Vergnaud Grazzini & Herman Rosenberg, 1969, p. 280ff.



**Figs 19, 20.** *Clio pyramidata* L., 1767 forma *tyrrhenica* f. nov. Tyrrhenian Sea, sample T74-65-10; **19.** RGM 570 872; **20.** RGM 570 871. **A.** Apertural view. **B.** Dorsal view. **C.** Left lateral view. **D.** Ventral view. **E, F.** Dorsal and left lateral views of protoconch.

**Figs 19, 20.** *Clio pyramidata* L., 1767 forma *tyrrhenica* f. nov. Mar Tirreno, campione T74-65-10; **19.** RGM 570 872; **20.** RGM 570 871. **A.** Vista aperturale. **B.** Vista dorsale. **C.** Vista laterale sinistra. **D.** Vista ventrale. **E, F.** Vista dorsale e laterale sinistra della protoconca.



? *Clio pyramidata* f. *pyramidata* Linné – Herman, 1971a, p. 614, 618, 619.

? *Clio pyramidata* f. *pyramidata* – Herman, 1971b, p. 475-477.

? *Clio pyramidata* f. *pyramidata* – Herman, 1981, p. 193-195.

## Description

The differences compared to other formae of *Clio pyramidata* are most obvious in juvenile specimens, in which the apical shell part is clearly curved dorsally, whereas both in f. *pyramidata* (Fig. 18) and f. *lanceolata* (Figs 16-17) it does not deviate from the shell's long axis. The lateral carinae form a wider apical angle than in f. *pyramidata*, but they do not diverge as strongly as in f. *lanceolata*. Furthermore, the dorso-ventral diameter is larger than in both other formae. Similar to f. *pyramidata* the protoconch is less slender than it is in f. *lanceolata*.

The new forma is exclusively found in assemblages also yielding many specimens of *Limacina retroversa*, which indicates a preference for colder water (and presumably a Weichselian age). In sample T74-65-10 the same form is also present in a number of limestone fragments, and the same limestone forms the infill of the *Clio* specimens (as well as that of *C. oblonga*, see below).

In sample T74-55-6 numerous specimens are present that I include in this form, but not all of them show the curvature of the apical shell part and the divergence of the lateral carinae is a bit stronger. Dorso-ventral diameter, apical angle and measurements of the protoconch, however are identical. Also in that sample abundant specimens of *Limacina retroversa* are present, as well as some apical fragments of *Clio oblonga*, but interestingly the same sample yielded numerous specimens of *Diacria trispinosa*, in well-developed, adult specimens, a feature indicating a bit 'less cold' water. In a way these specimens indicate a transition into f. *lanceolata*.

This new forma of *Clio pyramidata* has no formal taxonomic status as infrasubspecific names are not recognized by the ICZN rulings. Still, I prefer not to designate a subspecies, as supposingly it has a similar value as the other formae of *C. pyramidata*, viz. f. *lanceolata* and f. *pyramidata* s.str.

## Material examined

Bologna samples: J 74-19, RGM 570 484/many; T74-55-6, RGM 570 920/many, RGM 570 921/many protoconchs; T74-65-2, RGM 570 897/7 protoconchs; T74-65-10, RGM 570 871/1 (Fig. 20A-F), RGM 570 872/1 (Fig. 19A-D), RGM 570 873/12, 2 fragments, RGM 570 874/16.

Malta, MEDITS2007, sample G19-2, RGM 569 576/47 including some transitional forms to f. *lanceolata*.

## Discussion

Vergnaud Grazzini & Herman Rosenberg (1969) and Herman (1971a, b; 1981) claimed to have recognized the

presence of *Clio pyramidata* f. *pyramidata* in glacial or last glacial sections of cores from the southern Aegean, Ionian, Tyrrhenian and/or Algero-Provençal seas, as well as from the Levantine basin. As they did not illustrate specimens or even describe the differences this remains to be acknowledged. It seems more likely that actually specimens of the new form were collected.

### Subgenus *incertae sedis*

#### *Clio* (s. lat.) *polita* Pelseneer, 1888 (Fig. 22A-C)

(*Cleodora*) Gruppe *falcatum* Pfeffer, 1880: p. 96, figs 19, 19a, b (non Gould, 1852).

*Clio polita* (Craven, MS) Pelseneer, 1888: p. 60, pl. 2, figs 4-6.

*Eucio polita* (Craven M.S.) Pelseneer – Tesch, 1946: pp. 15, 30, pl. 3, fig. 12a-c.

*Clio polita* (ms. Craven) (Pelseneer, 1888) [*sic*] – van der Spoel, 1967: p. 75, figs 67-69.

*Clio andreae* (Boas, 1886) – van der Spoel, 1976: p. 49 (partim, non Boas, 1886, non fig. 34a, b = *Clio andreae*).

*Clio polita* Pelseneer, 1888 – Rosenberg, 2009, Malacolog website.

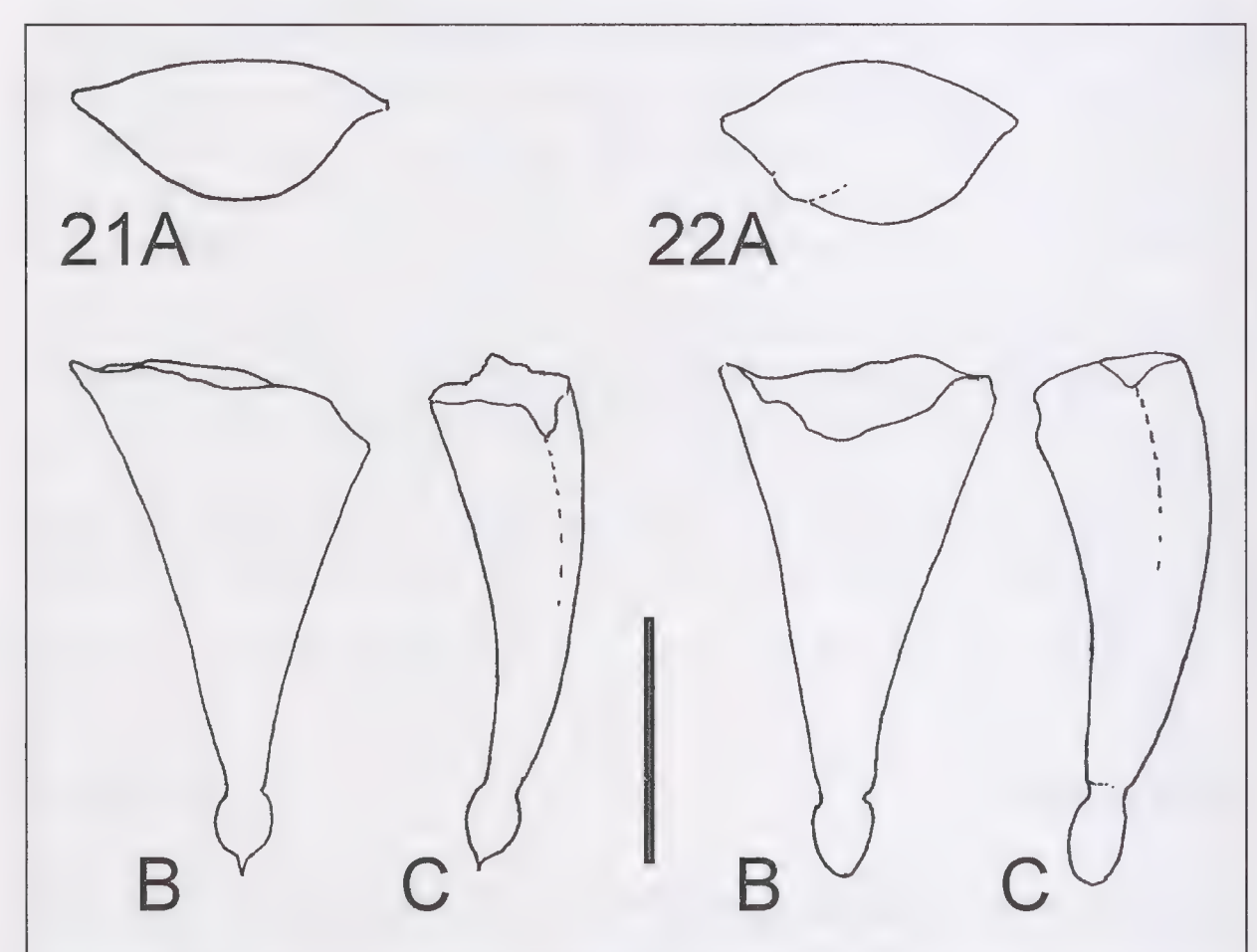
*Clio polita* Pelseneer, 1888 – WoRMS website, 2011.

*Clio andreae* (Boas, 1886) – ETI website, 2011 (partim, non Boas).

See for a number of erroneous references of this species under Genus *Clionidarum* sp. 1 and sp. 2 below.

## Description

See Pelseneer (1888), van der Spoel (1967). The single juvenile specimen found resembles *Clio cuspidata*. See Figs 21 and 22 for a comparison.



**Figs 21, 22.** *Clio* spp. **Fig. 21A-C.** *Clio* (*Bellardiclio*) *cuspidata* (Bosc, 1802), juvenile, RGM 570 848, sample CR 39, Ionian Sea. **Fig. 22A-C.** *Clio* (s. lat.) *polita* Pelseneer, 1888, juvenile, RGM 570 483, sample J 74-19, Ionian Sea. **A.** Apertural views. **B.** Dorsal views. **C.** Right lateral views. Bar length is 1 mm.

**Fig. 21, 22.** *Clio* spp. **Fig. 21A-C.** *Clio* (*Bellardiclio*) *cuspidata* (Bosc, 1802), esemplare juvenile, RGM 570 848, campione CR 39, Mar Ionio. **Fig. 22A-C.** *Clio* (s. lat.) *polita* Pelseneer, 1888, esemplare juvenile, RGM 570 483, campione J 74-19, Mar Ionio. **A.** Viste aperturali. **B.** Viste dorsali. **C.** Viste laterali destre. Scala = 1 mm.



## Material examined

Bologna samples: J 74-19, RGM 570 483/1 (Fig. 22A-C).

## Discussion

Van der Spoel (1976: p. 49, figs 34a, b) synonymized the taxa *Clio andreae* (Boas, 1886) and *C. polita* (Pelseneer, 1888), basing his opinion on shell fragments remaining of the holotype of *C. andreae*, of which he illustrated the apical part with protoconch. This point of view is maintained in van der Spoel et al. (1981: p. 514) and, not surprising, in the ETI (2011) website. Judging from the original descriptions and illustrations, however, there are clear differences, at least in shell morphology of adult specimens: in *C. andreae* both dorsal and ventral shell parts are longitudinally and transversally ornamented, weaker, but basically resembling *C. recurva* (Children, 1823), especially clear in Boas' figures 1, 12 and 92. In *C. polita*, as described and illustrated by Pelseneer (1888: pl. 2, figs 4, 5) and also by van der Spoel (1967: p. 75, figs 67, 68a, b) ornament (apart from the lateral carinae) is completely absent and in that species the dorso-ventral diameter is larger. Van der Spoel endorsed his opinion by stating that several authors (Munthe, 1888; Pelseneer, 1888; Meisenheimer, 1905, 1906; Pruvot-Fol, 1954, Vayssière, 1915) 'described *C. polita* under the name *C. andreae*', but Munthe and Pelseneer did not illustrate the shell and descriptions are not conclusive. Meisenheimer (1906: p. 107, figs a-c) and Vayssière (1915: p. 83, pl. 1, figs 23, 24, as *Cleodora curvata* Souleyet) illustrated a specimens with radial ornament, agreeing with *C. andreae*. Pruvot-Fol (1954: p. 118, fig. 33d, e) refers in her text to *Clio polita*, but what she illustrated is a distinct *C. andreae* (and is, curiously, correctly named *C. andreae* in the explanation of her fig. 33).

Rosenberg (2009), as well as the WoRMS website, accept both taxa as valid species, but the ETI (2011) website, again not surprising, still considers them to be synonyms. Both are not mentioned in the CLEMAM website. In the absence of sufficient material for comparison I consider it better to keep both taxa separate, as I find the fragmentary holotype of *C. andreae*, as illustrated by van der Spoel, not very convincing. It cannot be excluded, after all, that they represent extremes of intraspecific variability. In this respect *Clio falcata* (Pfeffer, 1880: p. 96, figs 19, 19a, b; non Gould, 1852) might represent an intermediate form. It was described and illustrated as having a weak indication of longitudinal ornament. Also, because of lacking ornament in *Clio polita* I hesitate to include that species in the subgenus *Balantium*, in which *C. andreae*, on the contrary, would fit very well considering its ornamentation. But both in *C. polita* and *C. andreae* the protoconch has a rounded tip, without apical spine.

This bathypelagic, to the Atlantic Ocean restricted species is generally considered to be absent from the Mediterranean, 'due to the shallow inflow of Atlantic waters' (Biekart, 1989: p. 205). Still, a single specimen in inter-

nal mould preservation was present in one of the Bologna samples from the Ionian Sea, accompanied by just a single specimen of *Firoloida desmarestia*, and many of *Limacina retroversa* and *Clio pyramidata* f. *pyramidata*, pointing to an origin from a somewhat cooler time. Other records of *C. polita* from the Mediterranean concern the larval shells of Gymnosomata (see below: Genus Clionidarum sp. 1 and sp. 2).

Family Cavoliniidae J.E. Gray, 1850

Genus *Cavolinia* Abildgaard, 1791

Type species – *Cavolinia natans* Abildgaard, 1791 (by monotypy) = *C. tridentata* (Forskål, 1775) (Recent).

*Cavolinia gibbosa* (d'Orbigny, 1834)

and f. *gibboides* Rampal, 2002

(Figs 23-28)

Synonyms for *C. gibbosa* s. lat.:

*Hyalæa gibbosa*, Rang, d'Orbigny, 1834: p. 95 (Rang inedit.).

*Hyalea gibbosa*, Rang – d'Orbigny, 1835: pl. 5, figs 16-20 (Rang inedit.).

*Hyalæa flava* d'Orbigny, 1834: p. 97.

*Hyalea flava*, d'Orb. – d'Orbigny, 1835: pl. 5, figs 21-25.

*Cavolinia gibbosa* Rang var. *plana* – Meisenheimer, 1905: p. 33, pl. 1, fig. 2.

*Cavolinia gibbosa* (ms. Rang) (Orbigny, 1836) – van der Spoel, 1967: p. 99, figs 97-102 (with extensive synonymy).

*Cavolinia gibbosa* – Pastouret, 1970: p. 238.

*Cavolinia gibbosa gibbosa* – Rampal, [1975], pp. 179ff, fig. 43ME1-4.

*Cavolinia gibbosa* (d'Orbigny – Bé & Gilmer, 1977: p. 768, fig. 13; pl. 9, fig. 29a-c.

*Cavolinia gibbosa* (d'Orbigby, 1835) – Gofas et al., 2001: p. 200 (partim).

Most probable synonyms for f. *gibboides*:

*Hyalæa gibbosa* Rang – Vérany, 1853: p. 380 (Rang inedit.).

*Cavolinia gibbosa* (Rang) – Menzies, 1958: p. 389, fig. 5a-c (Rang inedit.).

*Cavolinia gibbosa* (Rang) – van Straaten, 1966: p. 431 (Rang inedit.).

*Cavolinia gibbosa* (Rang) – Di Geronimo, 1970: p. 88, pl. 3, fig. 23; pl. 7, fig. 5a-c (Rang inedit.).

*Cavolinia gibbosa* (Rang) – Colantoni et al., 1970: p. 182, pl. 25, fig. 5a-c (Rang inedit.).

*Cavolinia gibbosa* (Rang) – Vatova, 1974: p. 109.

*Cavolinia gibbosa* (MS Rang) (d'Orbigny, 1836) – Almogi-Labin & Reiss, 1977: p. 7, pl. 1, fig. 1 (partim).

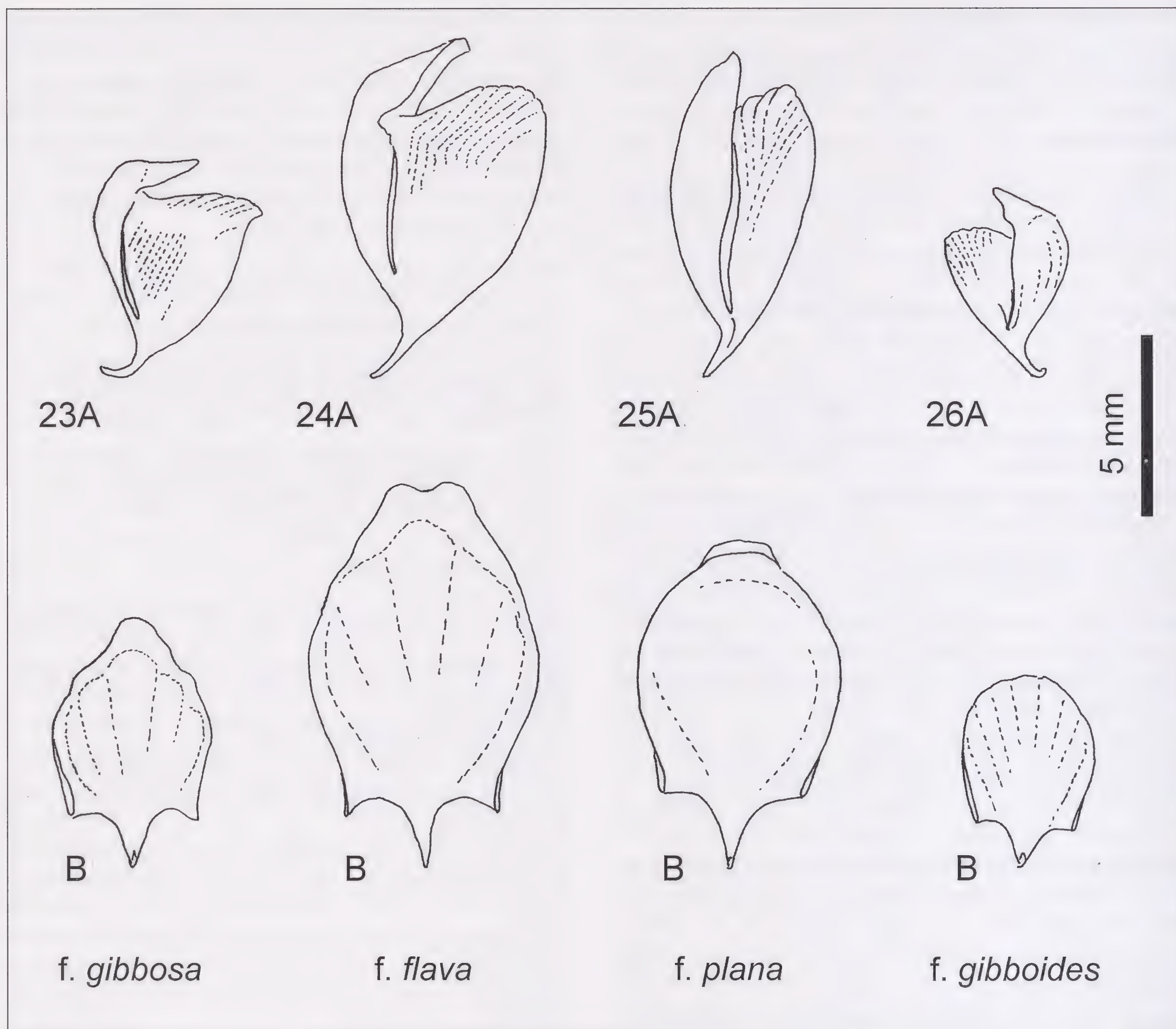
*Cavolinia gibbosa* (d'Orbigny) – Herman, 1981: p. 178, tabs. 4, 10-13.

*Cavolinia gibbosa gibbosa* (ms. Rang, d'Orbigny, 1836). – Corselli & Grecchi, 1987: p. 88, pl. 1, figs 1-4.

*Cavolinia gibboides* Rampal, 2002: p. 219, figs 4I-O, 22A, B.

*Cavolinia gibboides* Rampal, 2002 – Rampal, 2011: p. 383, figs 12, 12'.





**Figs 23-26.** *Cavolinia gibbosa* (d'Orbigny, 1834). Schematic outlines of the various forms based on the original illustrations. **Fig. 23.** Forma *gibbosa* (based on d'Orbigny, 1834: pl. 5, figs 18, 19). **Fig. 24.** Forma *flava* (based on d'Orbigny, 1834: pl. 5, figs 23, 24). **Fig. 25.** Forma *plana* (based on Meisenheimer, 1905: pl. 1, fig. 2a, b). **Fig. 26.** Forma *gibboides* (based on Rampal, 2002: figs 22A, B). All drawings approximately in the same magnification. **23A-25A.** Right lateral views. **26A.** Left lateral view. **23B-26B.** Dorsal views.

**Figs 23-26.** *Cavolinia gibbosa* (d'Orbigny, 1834). Contorni schematici delle varie forme basati sulle illustrazioni originali. **Fig. 23.** Forma *gibbosa* (basata su d'Orbigny, 1834: tav. 5, fig. 18, 19). **Fig. 24.** Forma *flava* (basata su d'Orbigny, 1834: tav. 5, fig. 23, 24). **Fig. 25.** Forma *plana* (basata su Meisenheimer, 1905: tav. 1, fig. 2a, b). **Fig. 26.** Forma *gibboides* (basata su Rampal, 2002: fig. 22A, B). Tutti i disegni sono approssimativamente allo stesso ingrandimento. **23A-25A.** Viste laterali destre. **26A.** Vista laterale sinistra. **23B-26B.** Viste dorsali.

*Cavolinia gibboides* Rampal, 2002 – WoRMS website, 2011.

## Description

See van der Spoel (1976), Almogi-Labin & Reiss (1977), Rampal (2002).

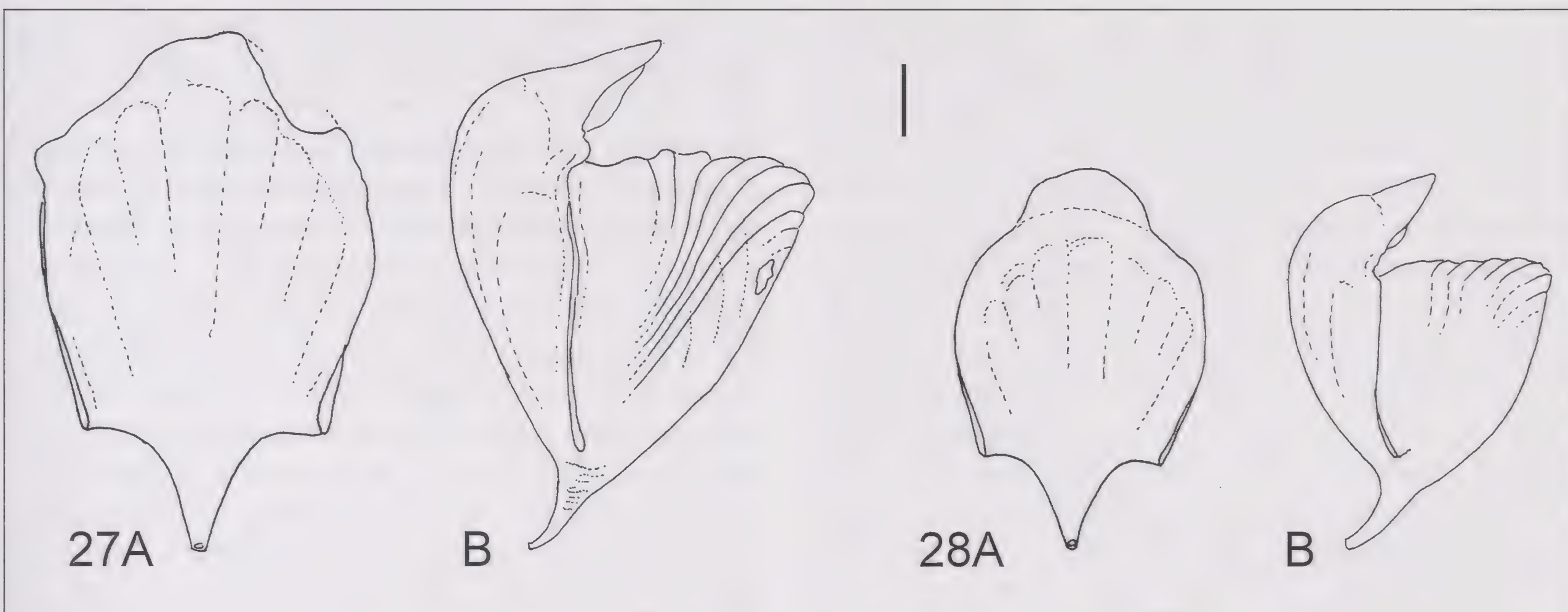
## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 529/many; Me25-13 Kg1, SMF 332894/4; Me25-13 Kg2, SMF 332909/1; Me25-15 Kg1, SMF 332931/14; Me25-15 Kg2, SMF 332950/26; Me25-15 Ku, SMF 332967/22; Me25-16 Kg1, SMF 332987/3; Me25-16 Kg2, SMF 333011/17; Me25-17 Kg1, SMF 333037/19; Me25-17 Kg2, SMF 333057/8; Me25-18 Kg1, SMF 333073/7;

Me25-18 Kg2, SMF 333089/10; Me25-19 Kg1, SMF 333105/15; Me25-19 Kg2, SMF 333124/18; Me25-20 Kg1, SMF 333143/4; Me25-20 Kg2, SMF 333164/15; Me25-20 Ku, SMF 333185/18; Me25-21 Kg1, SMF 333205/23; Me25-21 Kg2, RGM 569 503a/7 (*f. flava*), RGM 570 852/1 (**Fig. 27A, B**, *f. flava*), RGM 569 503b/11, RGM 570 853/1 (**Fig. 28A, B**); SMF 333225/76; Me25-22 Kg2, SMF 333245/42; Me25-23 Kg1, SMF 333268/13; Me25-23 Kg2, SMF 333287/37; Me25-23 Ku, SMF 333304/41; Me25-24 Kg1, SMF 333320/10; Me25-24 Kg2, SMF 333337/19; Me25-24 Ku, SMF 333346/5; Me25-25 Kg1, SMF 333348/1; Me25-37 Kg1, RGM 541 626/52, 14 protoconchs, RGM 541 627/4 (in praemetamorphosis stage); Me25-37 Ku, SMF 333366/42; Me25-38 Kg1, SMF 333384/21; Me25-38 Ku, SMF 333398/27; Me25-39 Kg1, SMF 333416/9; Me25-39 Kg2, SMF 333434/2.

Gravity core T87/2/20G: only (very) juvenile, specifi-





**Figs 27, 28.** *Cavolinia gibbosa* (d'Orbigny, 1834), East Mediterranean forms. **Fig. 27.** Forma *flava* (d'Orbigny, 1834). **Fig. 28.** Forma *gibboides* Rampal, 2002. Both specimens from sample Me25-21 Kg2, RGM 570 852-853. **A.** Dorsal views. **B.** Right lateral views. Bar length is 1 mm.

**Figs 27, 28.** *Cavolinia gibbosa* (d'Orbigny, 1834), forme del Mediterraneo orientale. **Fig. 27.** Forma *flava* (d'Orbigny, 1834). **Fig. 28.** Forma *gibboides* Rampal, 2002. Entrambi dal campione Me25-21 Kg2, RGM 570 852-853. **A.** Viste dorsali. **B.** Viste laterali destre. Scala = 1 mm.

cally unidentifiable specimens were found, specified below as *Cavolinia* sp.

Bologna samples: CJ 72 III-21, RGM 570 453/11, 7 fragments; CJ 72 III-23, RGM 570 424/3 fragments; CJ 72 III-25 (top), RGM 570 540/1, 1 fragment; CR 39, RGM 570 621/1; CR 42, RGM 570 368/1 fragment; J 74-9, RGM 570 507/12; J 74-12, RGM 569 831/1 (mould).

## Discussion

D'Orbigny (1834, see synonyms above) introduced two related *Cavolinia* species, i.e. *C. gibbosa* and *C. flava* respectively, differing in shell morphology and in colour of the soft parts. *C. gibbosa* is recorded as occurring in the Atlantic Ocean between 40° S and 34° N, whereas *C. flava*'s origin is 'la grand Océan austral', 30° S et 92° E' (of Paris !), which is in the southern Pacific Ocean off Chili. The main differences between these two taxa as given in the original descriptions, apart from the colours of the soft parts (blackish in *C. gibbosa* and yellow in *C. flava*), are the dimensions (H = 7.5 mm for *C. gibbosa*, H = 11 mm for *C. flava*), the strong angularity of the ventral shell part in *C. gibbosa*, more rounded in *C. flava*, the presence of seven longitudinal ribs on the dorsal shell part in *C. gibbosa* (but only five indicated in the illustration!), compared to five in *C. flava*. Also in *C. flava* the dorsal lip is less perpendicular to the shell's vertical axis than in *C. gibbosa* and finally in this latter species the apical spine is more strongly curved dorsally.

These differences, apart from the number of dorsal ribs, are clearly represented in the illustrations (see my schematic drawings of these types, **Figs 23-24**). They seem to be rather clear, but in a larger material it may frequently be difficult to separate the two taxa. Many authors therefore included both forms under the name of *C. gibbosa* and the name *C. flava* was hardly ever used. Lectotype and three paralectotypes (loc. type: Atlantic Ocean) of *C. gibbosa* are in coll. MHNP, remnants of the holotype (loc. type as given above) of *C. flava* are in

NHMUK 1854.12.4.13 (van der Spoel, 1976: p. 195-196).

Meisenheimer (1905: p. 32, pl. 1, fig. 2a, b) described a further form (**Fig. 25A, B**), from the Indian Ocean, as '*C. gibbosa* var. *plana*' with remarkably small dorso-ventral diameter and fading longitudinal ribs ('nahezu gänzlich verschwunden' = almost completely disappeared) on the dorsal shell part. Van der Spoel (1967) distinguished these three taxa as formae in *Cavolinia gibbosa*: *C. gibbosa* f. *gibbosa*, f. *flava* and f. *plana*, doubting the systematic value of the latter 'as it may represent an individual variation'. Some later authors considered these three taxa as subspecies.

Rampal (2002: p. 215ff), however, confused the situation around *Cavolinia gibbosa* and *C. flava* considerably by stating 'Les deux taxons atlantique et sud-atlantique *C. g. flava* (d'Orbigny, 1836) et *C. g. gibbosa* (d'Orbigny, 1836) ont été décrits sous le même nom: *C. gibbosa* (d'Orbigny, 1836)' [The two Atlantic and South Atlantic taxa, *C. g. flava* (d'Orbigny, 1836) and *C. g. gibbosa* (d'Orbigny, 1836) have been described with the same name: *C. gibbosa* (d'Orbigny, 1836)], forgetting that *C. flava* originally was introduced from the S Pacific. This author even re-evaluated the three existing forms as independent species, viz. *C. flava*, *C. gibbosa* and *C. plana*, giving distinguishing characteristics for a part disagreeing with the original diagnoses: her drawings of *C. flava*, for instance, (figs 2B, E, G, H) show a more accentuated angularity of the ventral shell part as what she illustrates as *C. gibbosa* (figs 5B, D), contrary to d'Orbigny's descriptions. Obviously she considered, also contrary to d'Orbigny, *Cavolinia gibbosa* to be restricted to the South Atlantic and to occur also in the western part of the Indian Ocean, whereas, although introduced from the South Pacific, she stated *C. flava* to be distributed all over the Atlantic. *C. plana* is distributed, according to Rampal, in the Indian and Pacific Oceans.

Then, Rampal (2002: p. 219, figs 4I-O, 22A, B) further introduced *C. gibboides* (**Fig. 26A, B**) as a species



new to science from the eastern Mediterranean and from the Gulf of Aqaba (the latter locality already referred to in Rampal, 1975: p. 328, as 'golfe d'Eylath'), but in her 2002 paper (p. 221) curiously specified as 'Golfe d'Aqaba. Cyprus'. A Gulf of Aqaba locality is certainly erroneous, see Janssen (2007a: p. 192). Also Dr Ahuva Almogi-Labin, first in Corselli & Grecchi (1987: p. 86), and again (in litt., November 2008) stated about its occurrence in the Gulf of Aqaba: '... based on numerous records that I studied of plankton tows and sediment samples that I never encountered a cavoliniid that is related to *C. gibbosa*'. The locality 'Cyprus' sounds much more acceptable, but it is not situated in the Gulf of Aqaba. Most probably Biekart's (1989: p. 214) reference to this species as occurring in the Red Sea is based on Rampal (1975).

Rampal gave several drawings and SEM images of *C. gibboides*, but without indicating which one is the holotype. As the drawings in her paper are rather primitive I based my outline drawing (Fig. 26A, B) on her SEM images (Rampal, 2002: p. 251, fig. 22a, b). Distinguishing criteria as maintained by Rampal (2002: p. 215, tab. 3, fig. 4Q) are predominantly uncontrollable morphometric data with in many cases overlapping values. She considered f. *plana* to be the most easily distinguished, not because of its small dorso-ventral dimension, but as it has only five radial ribs on the dorsal shell part: as a result of the reduced ornament the ribs tend to fuse or to disappear. Still, she also found specimens in which seven ribs are recognizable (Rampal, 2002, fig. 2K).

D'Orbigny (1834) explicitly described the presence of seven such ribs in *C. gibbosa* and five in *C. flava*. For *C. gibbosa* Rampal (2002, tab. 3) curiously gives '>5 à <7'. As 6 ribs cannot occur, we have to read this probably as '5 or 7'. These data on the number of radial ribs therefore do not concur with the original descriptions. It should be stressed here that counting longitudinal ribs in *Cavolinia* is hazardous, it is not always clear if the elongate lateral areas, that may frequently appear a bit swollen, are included or excluded. It would be much wiser to accept that all forms of *C. gibbosa* basically have seven ribs, that are sometimes reduced in strength and therefore cannot be counted accurately.

Many specimens in my E Mediterranean material have more strongly vaulted ventral shell parts than the shells illustrated by Rampal (2002). In sample Me 25-21 Kg2 several specimens make the impression of being fossils. Shells are chalky white and extremely fragile. Many of them reach larger dimensions (up to H = 9.35 mm) than the more recent looking specimens with transparent shells and agree in shape and size with the f. *flava*. Apart from size there is little difference with the fresh looking specimens. As they obviously are older than the fresh looking shells they probably represent an original more typical stock of *C. gibbosa* from which the f. *gibboides*, if one really wants to separate it, has evolved. Two specimens showing the diversity in this sample are illustrated Figs 27A, B and 28A, B.

The above remarks, together with the observation that many specimens from the eastern Mediterranean stud-

ied for the present paper are larger and usually clearly stronger vaulted than what was illustrated as *C. gibboides* by Rampal, lead me to the conclusion that van der Spoel's solution, recognizing one species, *Cavolinia gibbosa*, with various formae connected by intermediate morphs, is the most practical interpretation. Therefore I recognize *C. gibbosa* s.str. (with strongly vaulted ventral shell part and strongly curved apical spine), *C. gibbosa* forma *flava* (larger, with a less strongly vaulted, more rounded ventral shell part), *C. gibbosa* forma *plana* (with reduced dorso-ventral diameter and fading dorsal ornament) and f. *gibboides* (the smaller eastern Mediterranean form). It cannot be excluded of course, that molecular research will contradict these conclusions eventually, but in shell morphology all transitional forms are present.

The living eastern Mediterranean population is considered to be separated for a great deal from the Atlantic ones, which would mean that there is only little gene flow between them. The eastern Mediterranean population is considered to be 'définitivement séparés au moins du Pliocène' (Rampal, 2002: p. 221), whereas Corselli & Grecchi (1987) postulate an introduction from Atlantic stock into the eastern Mediterranean only about 8/9000 years ago.

Such separation, however, is made less probable by Cantraine (1841: p. 27, pl. 1, fig. 5), who observed living specimens of *C. gibbosa* rather common near Messina, which is on the boundary between the western and eastern basins. His description and illustration rather resemble f. *gibbosa*: strongly vaulted ventral shell part, apertural lip perpendicular to the shell's axis. Their size, however, (given as  $4\frac{3}{4}''$  = 10.7 mm? in Wikipedia, 2010) sounds more like f. *flava*. Anyway, as these specimens differ considerably from f. *gibboides*, Cantraine's observation disagrees strongly with Rampal's statement that 'Les rares spécimens récoltées dans le détroit de Messine et dans la mer sud-Tyrrhénienne ont valeur d'indicateur d'eau orientale profonde sortant du bassin oriental' [the few specimens collected in the strait of Messina and the southern Tyrrhenian Sea indicate deep oriental water run off from the oriental basin']. It rather seems to be vice versa, namely that the Atlantic form penetrates far into the Mediterranean, but only rarely reaches the eastern basin. Rampal (2011: p. 373), however, in a dichotomous identification table, mentioned *Cavolinia flava* only as very rare from the Alboran Sea, and *C. gibboides* only as abundant from the eastern Mediterranean. The only differentiating character given in her identification table between these two taxa, by the way, is the difference in size.

If a genetical separation indeed exists, or if a gene flow between the western and eastern Mediterranean populations is very restricted, the isolation may have led to a small form (H less than c. 6 mm) because of isolation and resulting endogamy, resembling forma *flava* in shape by its somewhat less strongly vaulted ventral shell part. The decision, however, if the actually living, local form has to be considered an independent species nowadays can only be demonstrated



by molecular techniques and therefore I treat *gibboides* likewise, and at least for the time being, as a forma of *C. gibbosa*.

Rosenberg (2009, Malacolog website) lists three of the four taxa as independant species, but omitted f. *gibboides* (as out of area?). The WoRMS website accepts *Cavolinia gibbosa*, *C. flava*, *C. gibboides* and *C. plana* as valid species. The ETI website recognizes *C. gibbosa* f. *gibbosa*, curiously considered by them to be distributed in the Indian and Pacific Oceans, f. *plana*, occurring in the Indo-Pacific, and f. *flava*, of which no geographic distribution is mentioned. Concerning the f. *plana* they make an interesting remark: 'It is doubtful if really full grown specimens are found in this form, probably only juveniles are concerned.' Indeed, it cannot be excluded that this form is based on specimens with as yet incomplete shell metamorphosis. ETI, by the way, erroneously includes several *Cavolinia* species in the Limacinidae. The CLEMAM website lists the names *flava*, *plana* and *gibboides* as synonyms of *C. gibbosa*.

Most of the following records just mention *Cavolinia gibbosa*, without a possibility to identify the forma. Vérany (1853) reported *C. gibbosa* as very rare from the sea near Nice. Oberwimmer (1898) caught this species alive at various stations in the eastern Mediterranean, and found it in bottom samples, also from the Adriatic Sea. Menzies (1958) recorded this species as ranking 7-8th in abundance, in both the central and eastern Mediterranean but did not find it in the western part. Herman (1981) considered this species to be a warm, subsurface water indicator, rare in the western basins, becoming increasingly more abundant east of the Strait of Sicily, and reaching peak abundances in the Aegean Sea. She recorded the species in low numbers from central Levantine, southern Aegean, Ionian and central Tyrrhenian cores, all from postglacial sediments. The species was absent in her cores from the Algero-Provençal Sea cores. This species was found to be common in two of four bottom samples from the Ionian Sea, and rare in the other two, by Vatova (1974). Almogi-Labin & Reiss (1977) recorded a single specimen from sediments or cores along the Israelian coast. Corselli & Grecchi (1990: p. 96) refer to a record of *Cavolinia globulosa* from the Mediterranean, considering it a probable misidentification of *C. gibbosa*. They also refer to occurrences of '*Cavolinia gibbosa flava*' in the western Mediterranean, explaining these by introduction from the Atlantic by currents. Rampal (2011) referred to *Cavolinia gibboides* as common in the eastern basin and mentioned *C. flava* as occurring very rarely in the Alboran Sea.

#### *Cavolinia inflexa* (Lesueur, 1813)

*Hyalæa inflexa* Lesueur, 1813: p. 285, pl. 5, fig. 4A-D.

f. *imitans* (Pfeffer, 1880)

(Figs 29A, B, 30A, B)

*Hyalea vaginellina* Cantraine, 1835: p. 380.

*Hyalæa vaginellina* – Cantraine, 1841: p. 28, figs 6, 6a.

*Hyalea Vaginella* [sic]-Contrain [sic] – Benoit, 1843: p. 4, pl. 1, fig. 4a-c.

*Hyalæa inflexa*, Lesueur – Vérany, 1853: p. 380.

\*(*Hyalea*) Form A. *imitans* Pfeffer, 1880: p. 90, fig. 9a.

*Hyalæa inflexa* Les. var. *longa* – Boas, 1886: p. 123, 212, pl. 6, figs 98d-f (partim, non figs 98a-c = *C. inflexa* f. *inflexa*).

*Cavolinia inflexa* var. *longa* (Rang) – Menzies, 1958: p. 390, fig. 6a-c.

*Cavolinia inflexa* (Lesueur) – van Straaten, 1966: p. 431.

*Cavolinia inflexa* (Lesueur, 1813) forma *imitans* (Pfeffer, 1880) – van der Spoel, 1967: p. 103, fig. 103a-c.

*Cavolinia inflexa* (Lesueur) – Blanc-Vernet et al., 1969: p. 220.

*Cavolinia inflexa* (Lesueur) – Pastouret, 1970: p. 238, pl. 2, fig. 3; pl. 3, fig. 1?

*Cavolinia inflexa* (Lesueur) – Di Geronimo, 1970: p. 91, pl. 3, fig. 5; plo. 7, figs 1a-c, 2a-c.

*Cavolinia inflexa* (Lesueur) var. *longa* Boas – Colantoni et al., 1970: p. 183, pl. 26, fig. 3a-c.

*Cavolinia inflexa* (Lesueur) – Herman, 1971a: p. 614.

*Cavolinia inflexa* – Herman, 1971b: p. 475ff.

*Cavolinia inflexa* f. *longa* – Herman, 1971b: p. 476.

*Gavolinia* [sic] *inflexa* (Lesueur) – Froget & Pastouret, 1972: p. 612ff.

*Cavolinia inflexa* (Lesueur) var. *lata* Boas – Vatova, 1974: p. 109.

*Cavolinia inflexa imitans* – Rampal, [1975]: p. 147ff, figs 34, 35a1-a4, 36

*Cavolinia inflexa* – Herman, 1981: p. 178, tabs. 4, 10-14

*Cavolinia inflexa* (Lesueur, 1813) – Grecchi, 1984: p. 18, pl. 1, fig. 13.

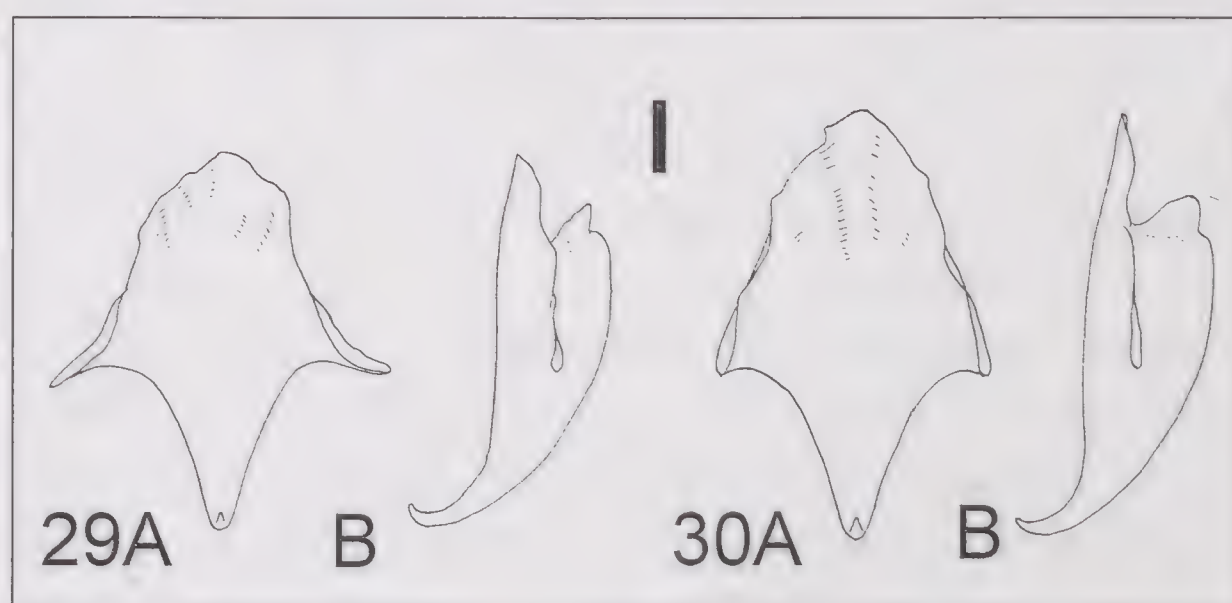
*Cavolinia inflexa* (Lesueur, 1813) – Corselli & Grecchi, 1987: p. 90, pl. 1, figs 5-6.

*Cavolinia inflexa* (Lesueur, 1813) – Grecchi & Bertolotti, 1988: p. 113, pl. 2, figs 1, 2.

*Cavolinia inflexa* subspecies *imitans* – Violanti et al., 1991: p. 24ff.

*Cavolinia inflexa* (Lesueur, 1813) – Gofas et al., 2001: p. 200 (partim).

*Cavolinia inflexa imitans* – Rampal, 2002: p. 225, figs 6, 7L, 8.



**Figs 29, 30.** *Cavolinia inflexa* (Lesueur, 1813) f. *imitans* (Pfeffer, 1880); sample Me25-37 Kg 1, RGM 569 484-485. **A.** Dorsal views. **B.** Right lateral views. Bar length is 1 mm.

**Figg. 29, 30.** *Cavolinia inflexa* (Lesueur, 1813) f. *imitans* (Pfeffer, 1880); campione Me25-37 Kg 1, RGM 569 484-485. **A.** Viste dorsali. **B.** Viste laterali destre. Scala = 1 mm.



*Cavolinia inflexa* (Lesueur, 1813) – Rosenberg, 2009, Malacolog website (partim).

*Cavolinia inflexa imitans* (Pfeffer, 1880) – ETI website, 2011.

*Cavolinia inflexa imitans* (Pfeffer, 1880) – WoRMS website, 2011.

*Cavolinia inflexa* (Lesueur 1813: *Hyalaea*) – CLEMAM website, 2011 (partim).

## Description

See Menzies (1958). In van der Spoel's (1967: p. 103, figs 103a-c) description of this form two incomprehensible statements occur. First, he described the upper aperture lip as 'sharply pointed', which rather is a characteristic valid for the *f. labiata* (see below) and in contradiction with his illustrations showing a rounded/truncated apertural lip. Second, he stated: 'most characteristic is the incision separating off the upper lip'. I fail to find such an incision and it is not indicated in his illustrations of *f. imitans*.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 530/11, 6 protoconchs; Me25-11 Kg1, SMF 332870/4; Me25-12 Kg2, SMF 332879/4; Me25-13 Kg1, SMF 332895/21; Me25-13 Kg2, SMF 332910/21; Me25-15 Kg1, SMF 332932/37; Me25-15 Kg2, RGM 569 487/15; SMF 332951/34, Me25-15 Ku, SMF 332968/19; Me25-16 Kg1, SMF 332988/10; Me25-16 Kg2, SMF 333012/31; Me25-17 Kg1, SMF 333038/25; Me25-17 Kg2, SMF 333058/24; Me25-18 Kg2, SMF 333090/5; Me25-19 Kg1, SMF 333106/12; Me25-19 Kg2, SMF 333125/9; Me25-20 Kg1, SMF 333144/23; Me25-20 Kg2, SMF 333165/60; Me25-20 Ku, SMF 333186/20, 9 protoconchs; Me25-21 Kg1, SMF 333206/21; Me25-21 Kg2, SMF 333226/61; Me25-22 Kg2, SMF 333246/78; Me25-23 Kg1, SMF 333269/9; Me25-23 Kg2, SMF 333288/12; Me25-23 Ku, SMF 333305/10; Me25-24 Kg1, SMF 333321/2; Me25-24 Kg2, SMF 333338/4; Me25-25 Kg1, SMF 333349/2; Me25-37 Kg1, RGM 541 628/5, RGM 569 483/1, RGM 569 484-485/2 (Figs 29-30); Me25-37 Ku, SMF 333367/6; Me25-38 Kg1, SMF 333385/7; Me25-38 Ku, SMF 333399/13; Me25-39 Kg1, SMF 333417/13; Me25-39 Kg2, SMF 333435/12; Me51/3-562, DCS RGA501/8.

Gravity core T87/2/20G: only (very) juvenile, specifically unidentifiable specimens were found, specified below as *Cavolinia* sp.

Bologna samples: CJ 72 III-21, RGM 570 454/many; CJ 72 III-23, RGM 570 425/15; CJ 72 III-25 (top), RGM 570 541/2; CR 20, RGM 570 396/3; CR 31, RGM 570 476/3; CR 39, RGM 570 622/3; CR 42, RGM 570 366/6, 4 fragments; CR 68, RGM 570 729/1, 5 fragments; J 73-17, RGM 570 636/1; J 73-29, RGM 570 436/5; J 74-9, RGM 570 508/many; J 74-12, RGM 569 832/6; T74-65-1, RGM 570 954/2, 10 fragments; T74-65-2, RGM 570 898/2 fragments; T74-65-9, RGM 570 934/1, 3 fragments; T74-65-10, RGM 570 875/many.

## Discussion

*Cavolinia inflexa* is a common pteropod species with an almost worldwide distribution (van der Spoel, 1967, fig. 360), in which during the last decennia, apart from the typical form, two formae (or subspecies) used to be recognized, viz. *f. imitans* Pfeffer, 1880 and *f. labiata* (d'Orbigny, 1834). Most important distinguishing characteristics of these formae are the development of the lateral spines, the relative dimensions of the apical shell part below the level of the lateral spines, compared to the apertural part above the spines, and the shape of the dorsal apertural lip (van der Spoel, 1967, pp. 90, 101-103). In *Cavolinia inflexa f. inflexa* and *f. imitans* the apertural lip is rounded. In *f. inflexa* the apical part below the spines is longer than the apertural part. In *f. imitans* and *f. labiata* it is shorter and in the latter form the dorsal apertural lip is pointed instead of rounded. In the Mediterranean, acknowledged by the present samples, only *f. imitans* is present, but demonstrating a considerable variability in the development of the lateral spines (Figs 29-30).

Boas (1886), and also van der Spoel (1967), considered the various formae recognized within *C. inflexa* as a gradually changing series. Van der Spoel & Pierrot-Bults (1998) executed a morphometric study based on 45 samples from all over the world's oceans. They concluded: '*Cavolinia inflexa* (Lesueur, 1813) proves not to be composed of subspecies or formae, or to show clinal variation. ... There is no valid ground for the subdivision of the species into different taxa'. Quite on the contrary, however, Rampal (2002), also on the basis of morphometric data, concluded differently. She accepts not only the existence of two subspecies in *C. inflexa*, viz. *C. inflexa inflexa* and *C. inflexa imitans*, but even considers *C. labiata* to represent an independent species, in which she also includes a new subspecies, *C. labiata robusta* Rampal, 2002, based on some 'fossil' species from a bottom sample taken near the island of Réunion in the Indian Ocean. Furthermore, she introduced another two 'fossil' species, related to *C. inflexa*, i.e. *C. longicosta* Rampal, 2002 and *C. pachysoma* Rampal, 2002, both from a core in the Mediterranean, with a supposed age of less than 2 ka.

A distinction of two subspecies in Recent *C. inflexa* is inadmissible, not only as the differences are very small and subject to variability, but especially because their geographical distributions overlap considerably, as is clear from van der Spoel's (1967) distribution map. As far as *C. labiata* is concerned, the differences from *C. inflexa* as given by Rampal (2002) seem to be more convincing, but with currently no material for comparison available I am unable to agree or disagree. The narrow rib on the dorsal shell part as well as the pointed, triangular outline of the dorsal apertural lip might be good characteristics, but in this case too there is overlap in the distributions, and it should be made certain that no intermediates occur.

The taxon *Hyalea vaginellina* Cantraine (1835: p. 380; more extensively described and illustrated in Cantraine,



1841: p. 28, pl. 1, fig. 6, 6a) was considered by Tesch (1913: p. 52), van der Spoel (1967: p. 101-102) and the ETI website to be a synonym of *Cavolinia inflexa* (f.) *inflexa*. Cantraine's illustration shows a specimen of which the apical part below the spines is not clearly higher than the shell part above the spines and his material originated from near Messina in the Mediterranean, meaning that it represents an earlier name for *C. inflexa* f. *imitans*, and not, as supposed by the mentioned authors, of the f. *inflexa*. As in the case of *Limacina retro-versa*, above, I make the following statements:

1. Of the names *Hyalea vaginellina* Cantraine, 1835 and *Hyalea imitans* Pfeffer, 1880 the latter is valid by prevailing usage;
2. The name *Hyalea vaginellina* has not been in use after 1899 (van der Spoel, 1967, pp. 101-102) (ICZN 23.9.1.1);
3. The name *Hyalea imitans* Pfeffer, 1880, frequently in combination with the genus *Cavolinia*, has been used in more than 25 papers, published by more than 10 authors during the immediate preceding 50 years, encompassing a span of more than 10 years (ICZN 23.9.1.2).
4. These statements make the taxon *Hyalea vaginellina* to a *nomen oblitum*, and the name *Hyalea imitans* to a *nomen protectum*.

Herman (1971a) mentioned *Cavolinia inflexa* from post-glacial sediments in the Levantine Basin and in 1971b, as *C. inflexa* f. *longa*, from similar intervals in the Ionian Sea. Herman (1981) interpreted this species as a temperate water species with a wide depth range distribution, abundant in the western basin, reaching peak abundances in the Ligurian and Provençal basins, decreasing in abundance in the Tyrrhenian and Adriatic, and even being rare in the Ionian and Levantine basins. She recorded the species in low numbers from postglacial parts of cores in the central Levantine, southern Aegean, Ionian, central Tyrrhenian and Algero-Provençal seas. Many further authors also recorded this species dead or alive from the Mediterranean (see the list of synonyms above). In the gravity core and in many of the bottom samples juvenile *Cavolinia* specimens were found, that I consider specifically unidentifiable, but it is evident that most of these belong to the present species. Such juvenile specimens are specified below as *Cavolinia* sp.

*Cavolinia tridentata* (Forskål, 1775)  
(Fig. 31A, B)

*Anomia tridentata* Forskål, 1775: p. 124.

*Anomia tridentata* – Forskål, 1776: p. 13, pl. 40, figs B, B1, B2.

*Hyalea tridentata* – delle Chiaje, 1830: pl. 80, fig. 1.

*Hyalæa tridentata*. Lam. – Cantraine, 1841: p. 26, figs 5a-d n (non Lamarck).

*Hyalæa tridentata*, Lam. – Vérany, 1853: p. 379 (non Lamarck).

*Cavolinia tridentata* Vér. – Oberwimmer, 1898: p. 591 (non Vérany).

*Cavolinia tridentata* Forskål – Steuer, 1911: p. 721, 722, figs 5-7.

*Cavolinia tridentata* (Forsk.) – Tesch, 1913: p. 49, fig. 44A, B.

*Cavolinia tridentata* Forskål – van Straaten, 1966: p. 431.

*Cavolinia tridentata* (ms. Forskål) (Niebuhr, 1775) forma *tridentata* (ms. Forskål) (Niebuhr, 1775) – van der Spoel, 1967: p. 94, figs 89, 90 (with extensive synonymy).

*Cavolinia tridentata* – Pastouret, 1970: p. 238.

*Cavolinia tridentata* (Forskål) – Di Geronimo, 1970: p. 86, pl. 6, figs 1a-c, 2a-c, 3a-c (non pl. 3, fig. 1 (= *Cavolinia* sp. indet.)).

*Cavolinia tridentata* (Forsk.) – Colantoni et al., 1970: p. 183, pl. 25, fig. 6a-c.

*Cavolinia tridentata* (Forskål) – Herman, 1971a: p. 614.

*Cavolinia tridentata* – Herman, 1971b: p. 475ff.

*Cavolinia tridentata* (Forskål) – Froget & Pastouret, 1972: p. 612ff.

*Cavolinia tridentata* – Vatova, 1974: p. 109.

*Cavolinia tridentata* – Rampal, [1975]: p. 198, figs 52.

*Cavolinia tridentata* (Niebuhr). – Bé & Gilmer, 1977: p. 784, fig. 27; pl. 8, fig. 26a-d.

*Cavolinia tridentata* (Forskål) – Herman, 1981: p. 178.

*Cavolinia tridentata* (ms. Forskål) (Niebuhr, 1775) – Grecchi, 1984: p. 17, pl. 1, fig. 9.

*Cavolinia tridentata* (Forskål) – Gofas et al., 2001: p. 200.

*Cavolinia tridentata* (Forskål, 1775) – Rosenberg, 2009, Malacolog website.

*Cavolinia tridentata* (Forskål, 1775)–WoRMS website, 2011.

*Cavolinia tridentata* (Forskål 1775: *Anomia*)– CLEMAM website, 2011.

*Cavolinia tridentata tridentata* – ETI website, 2011.

## Description

See van der Spoel (1967), Bé & Gilmer (1977). This is a large cavoliniid (exceptionally even up to 20 mm), originally described (Forskål, in Niebuhr, 1775) from the Mediterranean, easily distinguished by its size and brownish colour, making even smaller fragments recognizable. Contrary to other *Cavolinia* species its larval shell is hardly or not curved in dorsal direction. By its considerable size more or less complete specimens are only found in larger bottom samples.

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 531/many fragments; Me25-13 Ku, SMF 332915/1; Me25-15 Kg2, SMF 332952/1; Me25-15 Ku, SMF 332969/3; M26-16 Kg2, RGM 569 491/1, RGM 570 851/1 (Fig. 31A, B), SMF 333013/6; Me25-16 Ku, SMF 333020/7; Me25-17 Kg1, SMF 333039/6; Me25-19 Kg1, SMF 333107/2; Me25-19 Kg2, SMF 333126/6; Me25-20 Kg1, SMF 333145/1; Me25-20 Ku, SMF 333187/1; Me25-21 Kg1, SMF 333207/3; Me25-22 Kg2, SMF 333247/2; Me25-23 Ku, SMF 333306/4; Me25-37 Kg1, RGM 541 629/1 fragment; Me25-37 Ku, SMF 333368/7; Me25-38 Kg1, SMF 333386/1; Me25-38 Ku, RGM 569 506/2, SMF 333400/9.

Bologna samples: CJ 72 III-21, RGM 570 455/35 fragments; CR 31, RGM 570 477/2 fragments; J 73-17, RGM



570 637/2; J 73-29, RGM 570 437/5 fragments; J 74-9, RGM 570 509/2 fragments; J 74-12, RGM 569 834/5 fragments; T74-65-1, RGM 570 955/fragments of 1 specimen; T74-65-2, RGM 570 899/3 fragments; T74-65-9, RGM 570 935/3 fragments; T74-65-10, RGM 570 876/many fragments.

## Discussion

*Cavolinia tridentata* has been referred to in literature with quite a number of synonyms (see van der Spoel, 1967). Tesch (1913: p. 49ff) distinguished three subspecies, namely *C. tridentata tridentata*, *C. t. affinis* (d'Orbigny, 1836) and *C. t. kraussi* Tesch, 1913. Van der Spoel (1974) discussed infraspecific variability and geographical distribution, distinguishing nine formae, five (not four, as said in the abstract) of which were introduced as new. In the Mediterranean only f. *tridentata* is present. Rosenberg (2009) lists all nine forma names as synonyms of *C. tridentata*, whereas ETI (2011) considers all of them to be subspecies. The CLEMAM website lists some as synonyms, some as subspecies, but the five formae introduced by van der Spoel (1974) as 'variety'. The species is recorded, dead and alive, from the Mediterranean by many authors (see synonyms).

### *Cavolinia uncinata* (d'Orbigny, 1834) (Fig. 32A, B)

*H[yalea] uncinata* – Rang, 1829: p. 114 (*nomen nudum*).

*Hyalæa uncinata*, Rang, d'Orbigny, 1834: p. 93.

*Hyalea uncinata*, Rang – d'Orbigny, 1835: pl. 5, figs 11-15.

*Cavolinia uncinata* (Rang, 1829) – van der Spoel, 1967: p. 97, figs 91, 92 (with extensive synonymy).

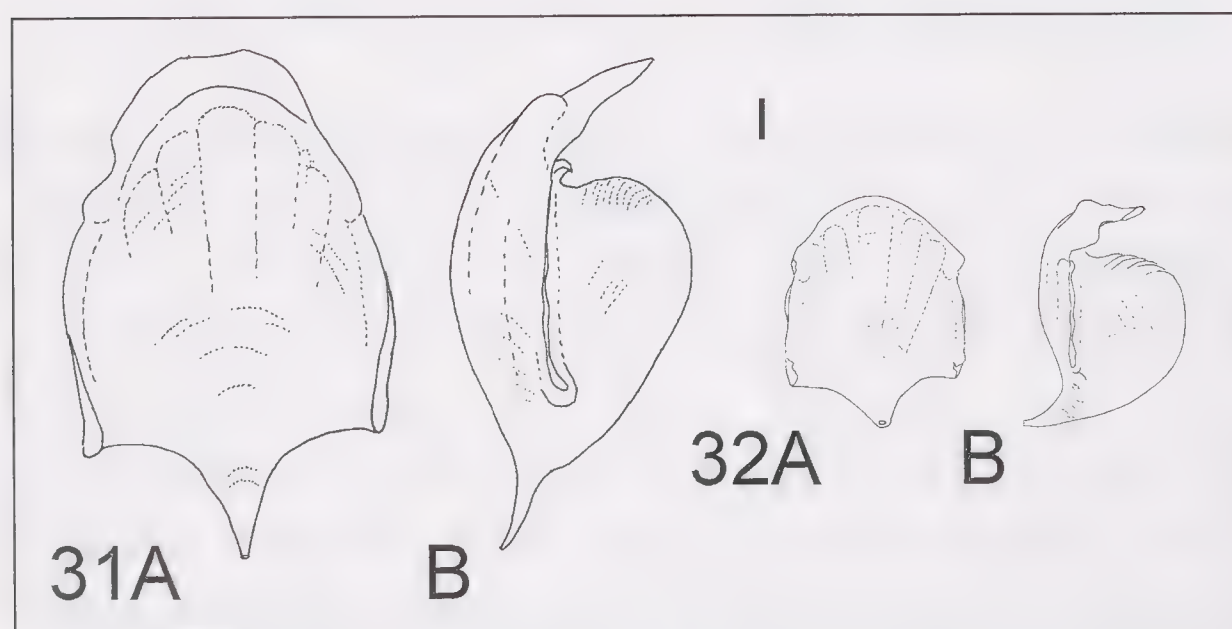
*Cavolinia uncinata* (Rang) – Herman, 1971a: p. 614.

*Cavolinia uncinata* – Herman, 1971b: p. 475ff.

*Cavolinia uncinata* (Rang) – Bé & Gilmer, 1977: p. 770, fig. 17; pl. 9, fig. 30a-c.

*Cavolinia uncinata* (Rang, 1829) – Rampal, 1979: p. 149, fig. 1e1.

*Cavolinia uncinata* – Corselli & Grecchi, 1990: p. 96.



**Figs 31, 32.** *Cavolinia* spp. **Fig. 31A, B.** *Cavolinia tridentata* (Forskål, 1775); sample Me 25-16 Kg2, RGM 570 851. **Fig. 32A, B.** *C. uncinata* (Rang, 1829); sample Me25-25 Kg1, RGM 569 505. **A.** Dorsal views. **B.** Right lateral views. Bar length is 1 mm.

**Figs 31, 32.** *Cavolinia* spp. **Fig. 31A, B.** *Cavolinia tridentata* (Forskål, 1775); campione Me 25-16 Kg2, RGM 570 851. **Fig. 32A, B.** *C. uncinata* (Rang, 1829); campione Me25-25 Kg1, RGM 569 505. **A.** Viste dorsali. **B.** Viste laterali destre. Scala = 1 mm.

*Cavolinia uncinata* (Rang, 1829) – Gofas et al., 2001: p. 200.

*Cavolinia uncinata* (Rang, 1829) – Rosenberg, 2009, Malacolog website.

*Cavolinia uncinata* (Rang in d'Orbigny, 1836) – WoRMS website, 2011.

*Cavolinia uncinata* (d'Orbigny 1834: *Hyalæa*) – CLEMAM website, 2011.

*Cavolinia uncinata uncinata uncinata* – ETI website, 2011.

## Description

See Tesch (1913), Bé & Gilmer (1977). Basically resembling *Cavolinia tridentata*, but remaining considerably smaller, with a more convex ventral shell part, a strongly curved caudal spine and a dorsal apertural lip perpendicular to the shell's axis.

## Material examined

Box core and beam trawl samples: Me25-25 Kg1, RGM 569 505/1 (**Fig. 32A, B**), SMF 333350/1, 5 fragments.

## Discussion

See Janssen (2007a) for the correct author of this taxon. Rosenberg (2009) still maintains Rang (1829) as the author, following earlier authors. Van der Spoel (1969, 1971) subdivided *Cavolinia uncinata* into two subspecies each with two formae. See Janssen (2007a) for a discussion. Rosenberg (2009) lists the van der Spoel (1969) names as synonyms, but does not mention the names introduced in 1971. The ETI (2011) website records all names either as formae or as 'subsubspecies' (e.g. as '*Cavolinia uncinata pulsatapusilla pulsatoides*'). CLEMAM (2011) considers these infraspecific names as (dubious?) synonyms, with which I fully agree.

*Cavolinia uncinata* is rarely caught alive (Rampal, 1975, 2011) from the western part of the basin. Herman (1971a, b; 1981) recorded this species (in subordinate numbers) from postglacial sediments in the Levantine Basin (but no description or illustration is given). She characterized this species as 'Very rare in the Mediterranean Sea, collected in plankton tows, this species is a good Atlantic water indicator present along the North African coast and in the southern Tyrrhenian Sea'. Corselli & Grecchi (1990) refer to some records of the species in the Mediterranean in Rampal (1975) and conclude that incidental occurrences in the extreme western Mediterranean (Strait of Gibraltar) might be explained by transportation through Atlantic currents. It was found, however, to be '*très abondant*' [very common'] (Rampal, 1979) in post-glacial sediments in the southern Tyrrhenian Sea, in an assemblage with abundant *Diacria trispinosa*, apparently demonstrating rather warm circumstances. The species, however, is absent from the Tyrrhenian Sea samples analyzed for this paper.

The presence of apparently Recent, or at least very fresh specimens, hardly ever recorded from the eastern Med-



iterranean is surprising. They were found in just one sample, Me25-25, which is the sample closest to the Suez Canal. *Cavolinia uncinata* is a common species in the northern part of the Red Sea (Singer, 1994; Janssen, 2007a) and most probably we are dealing with the first lessepsian pteropod species ever (Godeaux & Toulemon, 1990; Janssen & Peijnenburg, in press).

*Cavolinia* sp.  
(Fig. 50A-D)

## Description

Curved apical spines of *Cavolinia* species occur abundantly in many samples. They are specifically unidentifiable. In most cases they may be supposed to belong to the frequently occurring *Cavolinia inflexa* f. *imitans* (see above), some may also belong to *C. gibbosa*. Similar specimens were described and illustrated by Almogi-Labin & Reiss (1977: p. 7, pl. 1, fig. 1), Buccheri & di Stefano (1980: p. 182, pl. 1, fig. 5) and Buccheri (1984: p. 80, pl. 1, fig. 6a, b). Straight apical spines of *C. tridentata* are easily recognized, the few apical fragments found are referred to above under that species.

## Material examined (all protoconchs)

Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 079h/3 (Saalian).

Gravity core T87/2/20G, sample 2.785-2.795 m, RGM 569 085e/6; 2.73-2.74 m, RGM 569 086h/4; Gravity core T87/2/20G, 2.59-2.60 m, RGM 569 091h/2; 2.54-2.55 m, RGM 569 092g/1; 2.47-2.48 m, RGM 569 095j/3 protoconchs; 2.45-2.46 m, RGM 569 100f/3 protoconchs; 2.42-2.43 m, RGM 569 119f/22; 2.36-2.37 m, RGM 569 135/30, RGM 569 135a/1 protoconch (Fig. 50A, B), RGM 569 135b/1 protoconch (Fig. 50C, D); 2.33-2.34 m, RGM 569 165g/19; 2.30-2.31 m, RGM 569 181h/6; 2.24-2.25 m, RGM 569 202f/4; 2.21-2.22 m, RGM 569 225d/8; 2.16-2.17 m, RGM 569 254m/9; 2.14-2.15 m, RGM 569 266e/4; 2.14-2.15 m, RGM 569 271f/1; 2.03-2.04 m, RGM 569 284g/3; 1.97-1.98 m, RGM 569 292k/8; 1.91-1.92 m, RGM 569 300h/4; 1.72-1.73 m, RGM 569 305h/3; 1.72-1.73 m, RGM 569 313d/8; 1.68-1.69 m, RGM 569 324d/11; 1.65-1.66 m, RGM 569 326d/2; 1.61-1.62 m, RGM 569 327d/1 (Eemian).

Gravity core T87/2/20G, sample 1.53-1.54 m, RGM 569 330e/2; 1.48-1.49 m, RGM 569 331g/4 (Weichselian).

Gravity core T87/2/20G, sample 0.19-0.20 m, RGM 569 368g/1; 0.17-0.18 m, RGM 569 373j/7; 0.16-0.17 m, RGM 569 374i/3; 0.14-0.15 m, RGM 569 375j/22; 0.12-0.13 m, RGM 569 383g/28; 0.11-0.12 m, RGM 569 389g/12; 0.095-0.105 m, RGM 569 391g/2; 0.05-0.06 m, RGM 569 407e/20 (Holocene).

Bologna samples: CJ 72 III-20, RGM 570 415/5; CJ 72 III-21 (bottom), RGM 570 755/8; CJ 72 III-22, RGM 570 659/14; CJ 72 III-25 (top), RGM 570 542/many; CJ 72 III-27 (centre), RGM 570 700/7; CR 20, RGM 570 397/many; CR 31, RGM 570 478/23; CR 33, MZB (ex RGM 569 798)/16; CR 34, RGM 570 679/c. 30; CR 39, RGM

570 623/many; CR 42, RGM 570 367/c. 45; CR 68, RGM 570 730/many; CR 70, RGM 570 569/21; J 73-29, RGM 570 438/17; J 74-9, RGM 570 510/many, RGM 570 511/32 (in premetamorphosis stage); J 74-10, RGM 569 916/9; J 74-12, RGM 569 833/c. 50; T74-65-1, RGM 570 956/many; T74-65-2, RGM 570 900/18.

## Discussion

Among the material recorded by Almogi-Labin & Reiss (1977), from sediment samples and cores along the coast of Israel, just a single adult specimen of *Cavolinia gibbosa* was present, whereas all remaining material were embryonic shells or apical shell parts that could also belong to *Cavolinia inflexa*. It is not very probable that also *C. tridentata* was represented, as that species has a straight, not curved protoconch.

### Genus *Diacavolinia* van der Spoel, 1987

Type species – *Cavolinia longirostris* (de Blainville, 1821) (by monotypy, van der Spoel, 1987: p. 78) (Recent).

#### *Diacavolinia longirostris* (de Blainville, 1821)

*Hyalæa longirostris*, Lesueur, de Blainville, 1821: p. 81.

*Cavolina longirostris* (Lesueur) – Herman, 1971a, pp. 614, 618.

*Cavolinia longirostris* – Herman, 1971b: p. 475ff.

*Cavolinia longirostris* (Lesueur) – Herman, 1981: p. 178.

*Diacavolinia longirostris* (De Blainville, 1821) – van der Spoel et al., 1993: p. 132, figs 3a, b; pl. 1, figs 1-4.

## Discussion

Steuer (1911: p. 719) mentioned '*Cavolinia longirostris*' [sic] from the western Mediterranean and refers to literature data (Carus, 1890) for occurrences in the Adriatic. Rampal (1973, 2011) and others mention the occurrence of this species in the W and/or SW part of the Mediterranean, supposing an introduction from the Atlantic through the Strait of Gibraltar.

Herman (1971a, b, 1973, 1981), however, repeatedly listed *Cavolinia longirostris* as one of the species occurring in Mediterranean postglacial sediments, inclusive of the eastern basin, but without giving any description or illustration. As that species was subsequently never recorded and is absent from the present material, I guess that her identification needs to be acknowledged. Most probably based on her papers, the ETI website states "This form was found in the Pleistocene of the Mediterranean".

### Genus *Diacria* J.E. Gray, 1847

Type species – *Hyalea trispinosa* (by original designation, J.E. Gray, 1847: p. 203) = *Diacria trispinosa* (de Blainville, 1821) (Recent).

#### *Diacria* aff. *quadridentata* (de Blainville, 1821)

*Diacria quadridentata* (Lesueur) – Herman, 1971a: p. 617, 619.



- Diacria quadridentata* – Herman, 1971b: p. 475ff.  
*Diacria quadridentata danae* – Rampal, [1975]: p. 234, fig. 63M.  
*Diacria quadridentata* – Herman, 1981: p. 189.  
*Diacria quadridentata* group – van Leyen & van der Spoel, 1982: p. 101ff.  
*Diacria quadridentata* (ms. Lesueur) (De Blainville, 1821) – Grecchi & Bertolotti, 1988: p. 122, pl. 1, fig. 12.  
? *Diacria quadridentata* – Corselli & Grecchi, 1990: p. 99.  
*Diacria danae* Leyen & van der Spoel, 1982 – Rosenberg, 2009, Malacolog website.  
*Diacria danae* Leyen & van der Spoel, 1982 – WoRMS website, 2011.  
*Diacria danae* – ETI website, 2011.

## Description

See van Leyen & van der Spoel (1982) for a description of the various forms of what used to be named *Diacria quadridentata*, but were raised to species level by these authors.

## Material examined

Gravity core T87/2/20G (all protoconchs), sample 2.63-2.64 m, RGM 569 088/2; 2.59-2.60 m, RGM 569 090/8; 2.54-2.55 m, RGM 569 092h/1; 2.47-2.48 m, RGM 569 095k/3 protoconchs; 2.42-2.43 m, RGM 569 111/6; 2.36-2.37 m, RGM 569 136/1; 2.24-2.25 m, RGM 569 193/1 (Eemian).

## Discussion

Rampal (1975: p. 234) referred to specimens occurring in the western Mediterranean, immigrating from the Atlantic, with the name *Diacria quadridentata danae*. This agrees with the distribution map given by van Leyen & van der Spoel (1982). Originally described as a forma of *D. quadridentata* by van der Spoel (1971) *D. danae* was raised to species level, together with several further formae, in 1982. This is accepted by Rosenberg (2009) and the WoRMS and ETI websites (the latter also claiming the species as occurring in the Mediterranean Pleistocene), but the name does not occur in the CLEMAM website, similar as further taxa described by van Leyen & van der Spoel (1982). In 2011 Rampal refers to this species as *D. danae*.

Herman (1971a, b; 1981: p. 194) found *Diacria quadridentata* in interstadial sediments of cores from the southern Aegean Sea and described it as an 'indicator of Atlantic water, this warm-water taxon is a meso- and bathypelagic species, present in the Alboran Sea and in the western basin along the African coast'.

Corselli & Grecchi also refer to this species as belonging to the group of pteropods that are penetrating the Mediterranean from the Atlantic and occurring scarcely in the western part only. They mention an occurrence in the late Pleistocene part of a core from the eastern Mediterranean, published by Grecchi & Bertolotti (1988).

In the present material exclusively larval shells were

found only in the Eemian part of gravity core T87/2/20G, easily distinguished from *Diacria trispinosa* by the elliptical shape of protoconch-1. Such larval shells are, so far, unidentifiable to species and are therefore recorded here in open nomenclature.

## *Diacria trispinosa* (de Blainville, 1821) (Fig. 50E-H)

Hyale à trois pointes; *Hyalæa trispinosa*, Lesueur, de Blainville, 1821: p. 82.

*Hyalæa trispinosa*. Les. – Cantraine, 1841: p. 28, pl. 1, fig. 4 (non Lesueur).

*Hyalea tricuspidata*. Lesueur – Deshayes, 1853: p. 61, pl. 103, figs 2, 3 (non Lesueur).

*Hyalæa trispinosa*, Lesueur – Vérany, 1853: p. 380 (Lesueur inedit.).

*Cavolinia trispinosa* Pels. – Oberwimmer, 1898: p. 590 (non Pelseneer).

*Diacria trispinosa* (Lesueur) – Menzies, 1958: p. 391, fig. 1d (Lesueur inedit.).

*Diacria trispinosa* (Lesueur) – van Straaten, 1966: p. 431 (Lesueur inedit.).

*Diacria trispinosa* (ms. Lesueur) (Blainville, 1821) forma *trispinosa* (ms. Lesueur) (Blainville, 1821) – van der Spoel, 1967: p. 85, figs 76-78 (with extensive synonymy).

*Diacria trispinosa* (Lesueur) – Pastouret, 1970: p. 238, pl. 2, fig. 2; pl. 3, fig. 5.

*Diacria trispinosa* (Lesueur) – Colantoni et al., 1970: p. 182, pl. 24, fig. 12; pl. 25, fig. 4a, c.

*Diacria trispinosa* (Lesueur) – Herman, 1971a: p. 617-619 (Lesueur inedit.).

*Diacria trispinosa* – Herman, 1971b: p. 475ff.

*Diacria trispinosa* (Lesueur) – Froget & Pastouret, 1972: p. 612ff (Lesueur inedit.).

*Diacria trispinosa* (Lesueur) – Vatova, 1974: p. 109.

*Diacria trispinosa* – Rampal, [1975]: p. 223, fig. 60M.

*Diacria trispinosa* (MS Lesueur)(Blainville, 1821) – Almo-gi-Labin & Reiss, 1977: p. 12, pl. 6, fig. 2.

*Diacria trispinosa* (de Blainville) – Bé & Gilmer, 1977: p. 785, fig. 28; pl. 7, fig. 23a-d.

*Diacria trispinosa* (Blainville, 1821) – Rampal, 1979: p. 149.

*Diacria trispinosa* – Herman, 1981: p. 189.

*Diacria trispinosa* (Lesueur, 1821) – Grecchi, 1984: p. 17, pl. 1, fig. 12 (Lesueur inedit.).

*Diacria trispinosa* (Lesueur) – Buccheri, 1984: p. 80, pl. 1, fig. 5 (Lesueur inedit.).

*Diacria trispinosa* (ms. Lesueur)(De Blainville, 1821) – Grecchi & Bertolotti, 1988: p. 111, pl. 1, fig. 13.

*Diacria trispinosa* – Corselli & Grecchi, 1990: p. 98.

*Diacria trispinosa* (Lesueur, 1821) – Gofas et al., 2001: p. 200.

*Diacria trispinosa trispinosa* (Blainville, 1821) – Rampal, 2002: p. 244, figs 18, 19, 21I-K.

*Diacria rampali* Dupont, 1979 – Rampal, 2002: p. 247, figs 20D-L, 23 D (non figs 21I-K).

*Diacria rampali* L. Dupont, 1979 – Rosenberg, 2009, Malacolog website.



*Diacria trispinosa* (Blainville, 1821) – Rosenberg, 2009, Malacolog website.

*Diacria rampali* (Dupont, 1979) – WoRMS website, 2011.

*Diacria trispinosa* (Lesueur, 1821) – WoRMS website, 2011.

*Diacria rampali* Dupont 1979 – CLEMAM website, 2011.

*Diacria rampalae* – CLEMAM website, 2011.

*Diacria trispinosa* (Lesueur 1821) – CLEMAM website, 2011.

*Diacria rampali* Dupont, 1979 – ETI website, 2011.

*Diacria trispinosa trispinosa* – ETI website, 2011.

## Description

See van der Spoel (1967), Bé & Gilmer (1977).

## Material examined

Box core and beam trawl samples: Me25-16 Kg1, SMF 332989/1 protoconch; Me25-16 Kg2, RGM 569 490/2, SMF 333014/6; Me25-20 Kg1, SMF 333146/8; Me25-20 Kg2, SMF 333166/1; Me25-20 Ku, SMF 333187/1; Me25-21 Kg1, SMF 333208/1; Me25-21 Kg2, SMF 333227/3, 2 protoconchs; Me25-25 Kg1, SMF 333351/7; Me51/3-562, DCS RGA499/1.

Gravity core T87/2/20G, sample 2.785-2.795 m, RGM 569 082/38, RGM 569 082a/1 (Fig. 50E, F), RGM 569 082b/1 (Fig. 50G, H); 2.73-2.74 m, RGM 569 086i/44; 2.67-2.68 m, RGM 569 087e/3; 2.63-2.64 m, RGM 569 089f/2; 2.54-2.55 m, RGM 569 092i/2; 2.47-2.48 m, RGM 569 095l/5 protoconchs; 2.45-2.46 m, RGM 569 100g/1 protoconch; 2.42-2.43 m, RGM 569 119g/3 protoconchs; 2.16-2.17 m, RGM 569 254n/1 protoconch; 2.14-2.15 m, RGM 569 266f/1; 1.72-1.73 m, RGM 569 313f/1; 1.68-1.69 m, RGM 569 317/1 protoconch (Eemian).

Gravity core T87/2/20G, sample 0.25-0.26 m, RGM 569 365f/5 (Weichselian).

Gravity core T87/2/20G, sample 0.22-0.23 m, RGM 569 366i/3; 0.20-0.21 m, RGM 569 367i/2; 0.19-0.20 m, RGM 569 368h/1; 0.18-0.19 m, RGM 569 369j/2; 0.14-0.15 m, RGM 569 375k/1; 0.12-0.13 m, RGM 569 383h/3; 0.11-0.12 m, RGM 569 389h/1 (Holocene).

Bologna samples: CJ 72 III-20, RGM 570 416/5 protoconchs; CJ 72 III-21, RGM 570 456/1 fragment; CJ 72 III-22, MZB (ex mRGM 570 652)/1 protoconch; CJ 72 III-23, RGM 570 426/1; CJ 72 III-25 (top), RGM 570 543/2 protoconchs, 1 fragment; CJ 72 III-27 (centre), RGM 570 701/many protoconchs, some fragments; CR 20, RGM 570 398/9 protoconchs, 3 fragments; CR 33, MZB (ex RGM 569 799)/11 protoconchs, 2 fragments; CR 39, RGM 570 624/3 protoconchs, 3 fragments; CR 42, RGM 570 369/3 fragments; CR 68, RGM 570 731/5 protoconchs, 10 fragments; CR 70, RGM 570 570/27 protoconchs, 4 fragments; J 73-29, RGM 570 439/8 fragments; J 74-9, RGM 570 512/2 protoconchs; J 74-12, RGM 569 835/1 (mould); T74-55-6, RGM 570 922/12, RGM 570 923/many fragments, RGM 570 924/many protoconchs; T74-65-1, RGM 570 957/3 protoconchs; T74-65-2, RGM 570 901/2 protoconchs; T74-65-9, RGM 570 936/1 protoconch.

## Discussion

The WoRMS and CLEMAM websites refer to this species with the authorship of Lesueur. In the original description, de Blainville (1821: p. 79) refers to an unpublished manuscript of Lesueur, who at that time already lived in America, and had made his manuscript available to de Blainville ('le manuscrit m'a été confié' ['the manuscript was entrusted to me']). Several taxa are included in de Blainville (1821) with the name of Lesueur as the author, but apparently the text is not Lesueur's. So I think it not correct to cite Lesueur as the valid author, not even as 'Lesueur in de Blainville'. The name of *D. rampali* was correctly changed to *D. rampalae* in the CLEMAM website.

The taxonomy of the *Diacria trispinosa*-group was repeatedly discussed during the last half century (e.g.: van der Spoel, 1967; Dupont, 1979; Hilgersom & van der Spoel, 1987; Bleeker & van der Spoel, 1988; Bontes & van der Spoel, 1998; Rampal, 2002) and various formae were raised to species level and new taxa were introduced. For a discussion of these see Janssen (2004). For the time being I am only inclined to accept two separate species in the *D. trispinosa*-group, viz. *D. trispinosa* and *D. major* (Boas, 1886), whereas the validity of all other names will have to be demonstrated by molecular techniques. As far as I know *D. major* has never been recorded from the Mediterranean.

In the distribution map given by Bontes & van der Spoel (1998: p. 83, fig. 6) the only taxon entering the Mediterranean from the Atlantic is '*Diacria rampali*' Dupont, 1979. In the map for *Diacria trispinosa trispinosa*, given in the ETI website only the Adriatic is indicated for the Mediterranean, whereas in their map for *D. rampali* the western Mediterranean is indicated as 'insufficient data'. Rampal's (2002, fig. 21K) distribution map contrarily indicates the sole presence of *D. t. trispinosa* in the western Mediterranean.

Cantraine (1841) found living specimens of this species in the area of Messina and also reported on several fossil occurrences on the Italian mainland. This species was reported as occurring very rarely near Nice by Vérany (1853). Exclusively dead specimens were recorded by Oberwimmer (1898) from few bottom samples in the eastern Mediterranean and the Adriatic Sea.

Menzies (1958) only recorded specimens from eastern Mediterranean core sediments. Also Herman (1971a, b, 1981) found this species in postglacial parts of cores from the southern Aegean Sea and the Levantine Basin. She characterized the species as having a similar distribution as *Diacria quadridentata* and as a 'warm-water sub-surface Atlantic water indicator', somewhat more abundant and more widespread than *D. quadridentata*, penetrating into the eastern basin. Vatova (1974) recorded six specimens from two bottom samples in the Ionian Sea. Corselli & Grecchi (1990) summarized western Mediterranean occurrences, concluding on introduction into the Mediterranean by currents from the Atlantic. Rampal (2011) records *Diacria trispinosa* as rare in the SW Mediterranean and the S Tyrrhenian Sea.



The ETI website summarizes the known fossil distribution (of *Diacria trispinosa trispinosa*) as follows: 'This species was known from the late Quaternary (last interglacial: 100,000 years BP) of the Red Sea, and the Pleistocene of the Mediterranean, and Adriatic. From the Adriatic this forma disappeared in the Atlanticum. It penetrated the Adriatic already in the Older Dryas. It was found in the middle Pliocene of Italy'. The source of these data is not given.

In the material studied for the present paper this species, represented predominantly by protoconchs and fragments of the teleoconch, is relatively common in the Eemian interval of gravity core T87/2/20G, but a few specimens were also present in the Weichselian and Holocene parts. Also in the Bologna samples this species is frequently found, albeit usually not in larger numbers and predominantly as protoconchs, with the exception of one sample (T74-55-6) from the Tyrrhenian Sea that yielded fully grown, complete specimens and many fragments.

Superfamily Cymbulioidea J.E. Gray, 1840

Family Cymbuliidae J.E. Gray, 1840

Note: In the Cymbuliidae family two subfamilies and three genera are distinguished, viz. *Cymbulia* Péron & Lesueur, 1810 in the Cymbuliinae, and *Corolla* Dall, 1871 and *Gleba* Forskål, 1776, in the Glebinae. The species only have a calcareous shell during the larval stage. In adult specimens a so-called 'pseudoconch' is present, a gelatinous but still rather solid organ, more or less in the shape of a shoe, completely covered by mantle tissue in the living animal. The larval shells have hardly ever been described and are therefore not identifiable to species level, the more so as even the taxonomy of adult individuals is not ascertained yet. See Lalli & Gilmer (1989: p. 152).

Subfamily Cymbuliinae J.E. Gray, 1840

Genus *Cymbulia* Péron & Lesueur, 1810

Type species – 'Cymbulie Proboscidee' = *Cymbulia proboscidea* Lamarck, 1816 (*nomen oblitum*) = *Cymbulia peronii* de Blainville, 1818 (*nomen protectum*) (by original designation; see Janssen, 2007: p. 162) (Recent).

Note: Several species have been described within this genus, two of which are recorded as occurring in the Mediterranean by Rampal (1975: p. 242; 2011: p. 374) and van der Spoel (1976: p. 36-39, figs 1776, 178), viz. *Cymbulia peronii* de Blainville, 1818 (already recorded by Vérany, 1853 as common near Nice, Oberwimmer, 1898, and Steuer, 1911, from the Adriatic Sea) and *C. parvidentata* Pelseneer, 1888. The former is indicated for the Mediterranean as very abundant, the latter as rare (Rampal, 2011). As distinguishing characteristic predominantly the morphology of the pseudoconchs is applied. Van der Spoel distinguishes two 'morphs', both occurring in the Mediterranean, for *C. peronii*.

The occurrence of two species in the Mediterranean is

acknowledged by the present material of larval shells, which, however, cannot with certainty be related to the adult shell-less forms of the two existing species and are therefore included here in open nomenclature.

*Cymbulia* sp. 1

(Fig. 51A-G)

*Cymbulia* sp. 1 – Janssen, 2007a: p. 162, pl. 22, figs 4-6.

## Description (shell)

See Janssen (2007a).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 518/4; Me25-16 Kg2, SMF 333018/2.

Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 072/1, RGM 569 074/1 (Fig. 51F, G) (Saalian).

Gravity core T87/2/20G, sample 2.73-2.74 m, RGM 569 086j/19; 2.67-2.68 m, RGM 569 087g/4; 2.47-2.48 m, RGM 569 095m/2; 2.45-2.46 m, RGM 569 100h/2; 2.42-2.43 m, RGM 569 115/21; 2.36-2.37 m, RGM 569 139/20; 2.33-2.34 m, RGM 569 156/7; 2.30-2.31 m, RGM 569 175/1; 2.21-2.22 m, RGM 569 218/2; 2.18-2.19 m, RGM 569 235/25; 2.16-2.17 m, RGM 569 246/29; 2.14-2.15 m, RGM 569 262/6; 2.03-2.04 m, RGM 569 277/4; 1.97-1.98 m, RGM 569 287/7; 1.91-1.92 m, RGM 569 296/3; 1.79-1.80 m, RGM 569 303e/2; 1.76-1.77 m, RGM 569 304e/4; 1.72-1.73 m, RGM 569 305i/1; 1.72-1.73 m, RGM 569 309/14; 1.72-1.73 m, RGM 569 313e/14; 1.68-1.69 m, RGM 569 318/13, RGM 569 318a-d/4 (Fig. 51A-E); 1.65-1.66 m, RGM 569 326e/1 (Eemian).

Gravity core T87/2/20G, sample 1.33-1.34 m, RGM 569 333h/2; 0.50-0.51 m, RGM 569 352e/1 (Weichselian).

Gravity core T87/2/20G, sample 0.12-0.13 m, RGM 569 383i/1; 0.11-0.12 m, RGM 569 387/6 (Holocene).

Bologna samples: CJ 72 III-27 (centre), RGM 570 702/1; CR 33, MZB (ex RGM 569 800)/2; CR 34, RGM 570 680/4; CR 39, RGM 570 625/6; CR 42, RGM 570 370/14; CR 68, RGM 570 732/1; CR 70, RGM 570 571/1; J 74-9, RGM 570 513/many; J 74-10, RGM 569 917/5.

## Discussion

The Mediterranean material of this species agrees completely with the specimens recorded from the Red Sea by Janssen (2007a). In gravity core T87/2/20G the present species is especially common during the Eemian interval, and present during the Weichselian and Holocene in just a few specimens. If *Cymbulia* sp. 2 indeed is *C. peronii* (see below), then it is imaginable that *Cymbulia* sp. 1 represents *C. parvidentata*.

Interestingly, specimens closely resembling this species were recently recorded from Eocene (Ypresian/Lutetian) deposits in Uzbekistan (Janssen et al., 2011), demonstrating the occurrence of the genus already more than 40 Ma earlier than could be supposed to date.



*Cymbulia* sp. 2  
(Fig. 51H-L)

*Cymbulia* sp. 2 – Janssen, 2007: p. 163, pl. 22, figs 7-9.  
? *Cymbulia peroni* – Rampal, 2011: p. 374, fig. 7-3, 3'.

Description (shell)

See Janssen (2007a). Just as was observed in the Red Sea material specimens of this type differ from *Cymbulia* sp. 1 by a slightly smaller size, but in having a quarter of a whorl more, with a markedly smaller nucleus.

Material examined

Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 073/1 (Saalian)

Gravity core T87/2/20G, sample 2.42-2.43 m, RGM 569 1116/69; 2.36-2.37 m, RGM 569 140/180, RGM 569 140a/1 (Fig. 51H), RGM 569 140b/1 (Fig. 51L); 2.33-2.34 m, RGM 569 157/96; 2.30-2.31 m, RGM 569 176/54; 2.24-2.25 m, RGM 569 197/67, RGM 569 197a-c/3 (Fig. 51I-K); 2.21-2.22 m, RGM 569 219/51; 2.18-2.19 m, RGM 569 236/16; 2.16-2.17 m, RGM 569 247/12; 2.14-2.15 m, RGM 569 263/6; 2.03-2.04 m, RGM 569 278/8; 1.97-1.98 m, RGM 569 288/27; 1.91-1.92 m, RGM 569 297/27; 1.72-1.73 m, RGM 569 305j/2; 1.68-1.69 m, RGM 569 319/4 (Eemian).

Gravity core T87/2/20G, sample 1.43-1.44 m, RGM 569 332i/1; 0.65-0.66 m, RGM 569 349e/2; 0.50-0.51 m, RGM 569 352f/1; 0.25-0.26 m, RGM 569 365g/6 (Weichselian). Gravity core T87/2/20G, sample 0.22-0.23 m, RGM 569 366k/1; 0.18-0.19 m, RGM 569 369l/2; 0.17-0.18 m, RGM 569 373l/1; 0.12-0.13 m, RGM 569 383j/4; 0.11-0.12 m, RGM 569 388/1; 0.05-0.06 m, RGM 569 402/9 (Holocene).

Bologna samples: CR 33, MZB (ex RGM 569 801)/5; CR 70, RGM 570 572/8; T74-65-2, RGM 570 902/2.

Discussion

Unfortunately the illustration of a larval specimen of *Cymbulia peronii* with shell in Rampal (2011) is not with certainty recognizable as *Cymbulia* sp. 1 or sp. 2. Considering the diameters of nucleus and aperture it resembles *Cymbulia* sp. 2 a bit more.

In gravity core T87/2/20G this species is even more common during the Eemian than *Cymbulia* sp. 1, but also rare in the Saalian, Weichselian and Holocene parts of the section.

Subfamily Glebinae van der Spoel, 1976

Genus *Corolla* Dall, 1871

Type species – *Corolla spectabilis* Dall, 1871 (by original designation, Dall, 1871: p. 137).

Note: Larval shells of species in the genus *Corolla* have not yet been described. Two species are recorded from the Mediterranean on the basis of adult specimens or pseudoconch.

*Corolla? chrysosticta* (Troschel, 1854)

*Tiedemannia chrysosticta* Krohn MS, Troschel, 1854: p. 218, pl. 9, figs 10, 11.

*Gleba chrysosticta* (ms Krohn) (Troschel, 1854) – van der Spoel, 1976: p. 44 (with further synonymy).

*Gleba chrysosticta* (ms Krohn) (Troschel, 1854) – Rampal, 1996, bp. 6, fig. 4D, E, fig. 5E.

*Gleba chrysostricta* [sic] (Troschel, 1854) – Rosenberg, 2009, Malacolog website.

*Gleba chrysosticta* (Troschel 1854: *Tiedemannia*) – CLEM-AM website, 2011.

*Gleba chrysostricta* [sic] – ETI website, 2011.

*Gleba chrysosticta* (Troschel, 1854) – WoRMS website, 2011.

Note: This species used to be included in the genus *Gleba* (e.g. Pelseneer, 1888; Meisenheimer, 1905; Tesch, 1913; van der Spoel, 1976), but Rampal (1996b: p. 10; 2011: p. 374) transferred it to the genus *Corolla*, referring to its occurrence in the Mediterranean as very rare. Van der Spoel (1976, fig. 183) indicates its presence in the western Mediterranean only. The various website authors leave this species in the genus *Gleba*.

*Corolla spectabilis* Dall, 1871

*Corolla spectabilis* Dall, 1871p. 138.

*Corolla spectabilis* Dall, 1871 – van der Spoel, 1976p. 41, fig. 22.

Note: A single pseudoconch of this species was recorded from the Strait of Messina by Berdar et al. (1982: p. 35, pl. 1, figs 1-3). It is not mentioned for the Mediterranean by van der Spoel (1976, fig. 181) or Rampal (2011).

Genus *Gleba* Forskål, 1776

Type species: *Gleba cordata* Forskål, 1776 (by monotypy) (Recent).

Note: Two species in the genus *Gleba* were recognized for the Mediterranean by Rampal (1975: p. 12), van der Spoel (1976: p. 43-44), and Gofas et al. (2001: p. 200), viz. *G. cordata* and *G. chrysosticta*. The latter species was transferred, however, to the genus *Corolla* by Rampal (1996b) (see above). Corselli & Grecchi (1990: p. 94) consider both names to be synonyms. Among the larval shells I do not find two types, and therefore I apply the name *G. cordata*.

*Gleba cordata* Forskål, 1776  
(Fig. 52A-G)

*Gleba cordata* Forskål, 1776: p. 14, pl. 43, fig. D.

*Gleba* sp. – Colantoni et al., 1970: p. 185, pl. 26, fig. 7.

*Gleba cordata* (ms Forskål) Niebuhr, 1776 – van der Spoel, 1976: p. 43, fig. 26 (with extensive synonymy).

*Gleba cordata* (ms Forskål)(Niebuhr, 1776) – Grecchi, 1984: p. 18, pl. 1, fig. 18.

? *Gleba* sp. – Buccheri & di Stefano, 1984: p. 182, pl. 1, fig. 10.



*Gleba chrysosticta* – Corselli & Grecchi, 1990: p. 94.  
*Gleba cordata* (ms. Forskal) Niebuhr, 1776 – Grecchi & Bertolotti, 1988: p. 116, pl. 2, fig. 8.  
*Gleba cordata* Niebuhr, 1776 – Kunz, [1996]: p. 156, pl. 27, figs 2-4 (non fig. 1 = *Pterotrachea* sp. 1).  
*Gleba cordata* Forskål, 1776 – Gofas et al., 2001, p. 200.  
*Gleba cordata* Niebuhr, 1776 – Rosenberg, 2009, Malacolog website.  
*Gleba cordata* Niebuhr 1776 – CLEMAM website, 2011.  
*Gleba cordata* Forskål, 1776 – WoRMS website, 2011.  
*Gleba cordata* (ms Forskal) Niebuhr, 1776 – ETI website, 2011.

### Description (of larval shell)

See Grecchi (1984), Grecchi & Bertolotti (1988).

### Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 5532/20; Me25-16 Kg2, SMF 333019/2; Me25-19 Kg2, SMF 333129/1; Me25-37 Kg1, RGM 541 632/1; Me51/3-562, DCS RGA512/2.  
 Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 075/6 (Saalian)  
 Gravity core T87/2/20G, sample 2.785-2.795 m, RGM 569 085f/1; Gravity core T87/2/20G, 2.73-2.74 m, RGM 569 086k/3; 2.54-2.55 m, RGM 569 092j/1; 2.47-2.48 m, RGM 569 095n/1; 2.45-2.46 m, RGM 569 1001/3; 2.42-2.43 m, RGM 569 117/45; 2.36-2.37 m, RGM 569 141/211; 2.33-2.34 m, RGM 569 158/127, RGM 569 158a-g/ (Fig. 52A-G); 2.30-2.31 m, RGM 569 177/123; 2.24-2.25 m, RGM 569 198/78; 2.21-2.22 m, RGM 569 220/54; 2.18-2.19 m, RGM 569 237/33; 2.16-2.17 m, RGM 569 248/40; 2.14-2.15 m, RGM 569 264/24; 2.14-2.15 m, RGM 569 271g/5; 2.03-2.04 m, RGM 569 279/19; 1.97-1.98 m, RGM 569 292l/6; 1.91-1.92 m, RGM 569 300i/5; 1.72-1.73 m, RGM 569 305k/8; 1.72-1.73 m, RGM 569 310/20; 1.68-1.69 m, RGM 569 320/26; 1.61-1.62 m, RGM 569 327e/1 (Eemian).  
 Gravity core T87/2/20G, sample 1.58-1.59 m, RGM 569 329d/2; 1.53-1.54 m, RGM 569 330g/1; 0.87-0.88 m, RGM 569 342d/1; 0.72-0.73 m, RGM 569 347f/1; 0.50-0.51 m, RGM 569 352g/1; 0.25-0.26 m, RGM 569 365h/3 (Weichselian).  
 Gravity core T87/2/20G, sample 0.22-0.23 m, RGM 569 366l/16; 0.20-0.21 m, RGM 569 367k/2; 0.19-0.20 m, RGM 569 368j/6; 0.18-0.19 m, RGM 569 369m/6; 0.17-0.18 m, RGM 569 373m/6; 0.14-0.15 m, RGM 569 375m/9; 0.12-0.13 m, RGM 569 380/20; 0.11-0.12 m, RGM 569 389i/5; 0.095-0.105 m, RGM 569 391h/1; 0.05-0.06 m, RGM 569 401/8 (Holocene).  
 Bologna samples: CJ 72 III-20, RGM 570 417/c. 35; CJ 72 III-21, RGM 570 457/1; CJ 72 III-21 (bottom), RGM 570 756/c. 40; CJ 72 III-22, MZB (ex RGM 570 653)/7; CJ 72 III-25 (top), RGM 570 544/12; CJ 72 III-27 (centre), RGM 570 703/many; CR 20, RGM 570 402/7; CR 33, MZB (ex RGM 569 802)/11; CR 34, RGM 570 681/10; CR 39, RGM 570 626/many; CR 42, RGM 570 371/many; CR 68, RGM 570 733/many; CR 70, RGM 570 573/many; J 73-29, RGM

570 440/1; J 74-9, RGM 570 514/many; J 74-10, RGM 569 918/8; J 74-12, RGM 569 836/8; T74-65-1, RGM 570 958/many (hundreds); T74-65-2, RGM 570 903/many.

### Discussion

Steuer (1911) considered this species to be restricted to the western Mediterranean (W of Sicily), but it is indicated to occur in the western Mediterranean and the Adriatic by van der Spoel (1976, fig. 183). According to Rampal (2011), it is rare all over the Mediterranean. The ETI website denies its presence in the eastern Mediterranean. From the present material it is at least evident that *Gleba cordata* has become extinct in the eastern basin only very recently.

In gravity core T87/2/20G the species is especially common during the Eemian interval, rare during the Weichselian, becoming more common again during the Holocene. Also in the various bottom samples shells of this species is usually present (if the finer sieving fractions are available).

Family Desmopteridae Chun, 1889

Genus *Desmopterus* Chun, 1889

Type species: *Desmopterus papilio* Chun, 1889 (by monotypy) (Recent).

*Desmopterus papilio* Chun, 1889

*Desmopterus papilio* Chun, 1889: p. 540, pl. 3, figs 11-14.

Note: Apart from the Cymbulioidea taxa discussed here the family Desmopteridae, with the species *Desmopterus papilio* Chun, 1889, is mentioned for the Mediterranean in van der Spoel (1976, fig. 184) as an immigrant from the Atlantic. Also Rampal (1975: p. 12) refers to Mediterranean occurrences. Batistić et al. (2007) record this species from the Adriatic. The ETI website (2011) states 'it does not normally penetrate most of the Mediterranean'. Rampal (2011: p. 375) mentions it as rare in the Mediterranean. A possible larval shell of this species has never been reported (but see the Discussion below under *Peracle?* sp.).

The anatomy of this in the adult stage shell-less species could also point to a systematic position within the Gymnosomata (van der Spoel, 1976: p. 45), in which group it was originally included by Chun (1889).

Family Peraclidae Frontier, 1963

Genus *Peracle* Forbes, 1844

Type species: *Peracle physoides* Forbes (1844: p. 186) (by monotypy) = *P. reticulata* (d'Orbigny, 1834) (Recent).

Note: The use of the genus name *Peracle* Forbes, 1844, rather than its emended replacement name *Peraclis* Pelseneer, 1888, is discussed in Cahuzac & Janssen (2010: p. 112), but *Peraclis* was already considered an unjustified modification by Giovine (1988: p. 22).

As identification of juvenile specimens of this genus can



be rather confusing schematical outline drawings of juvenile specimens are presented in Figs 33-37.

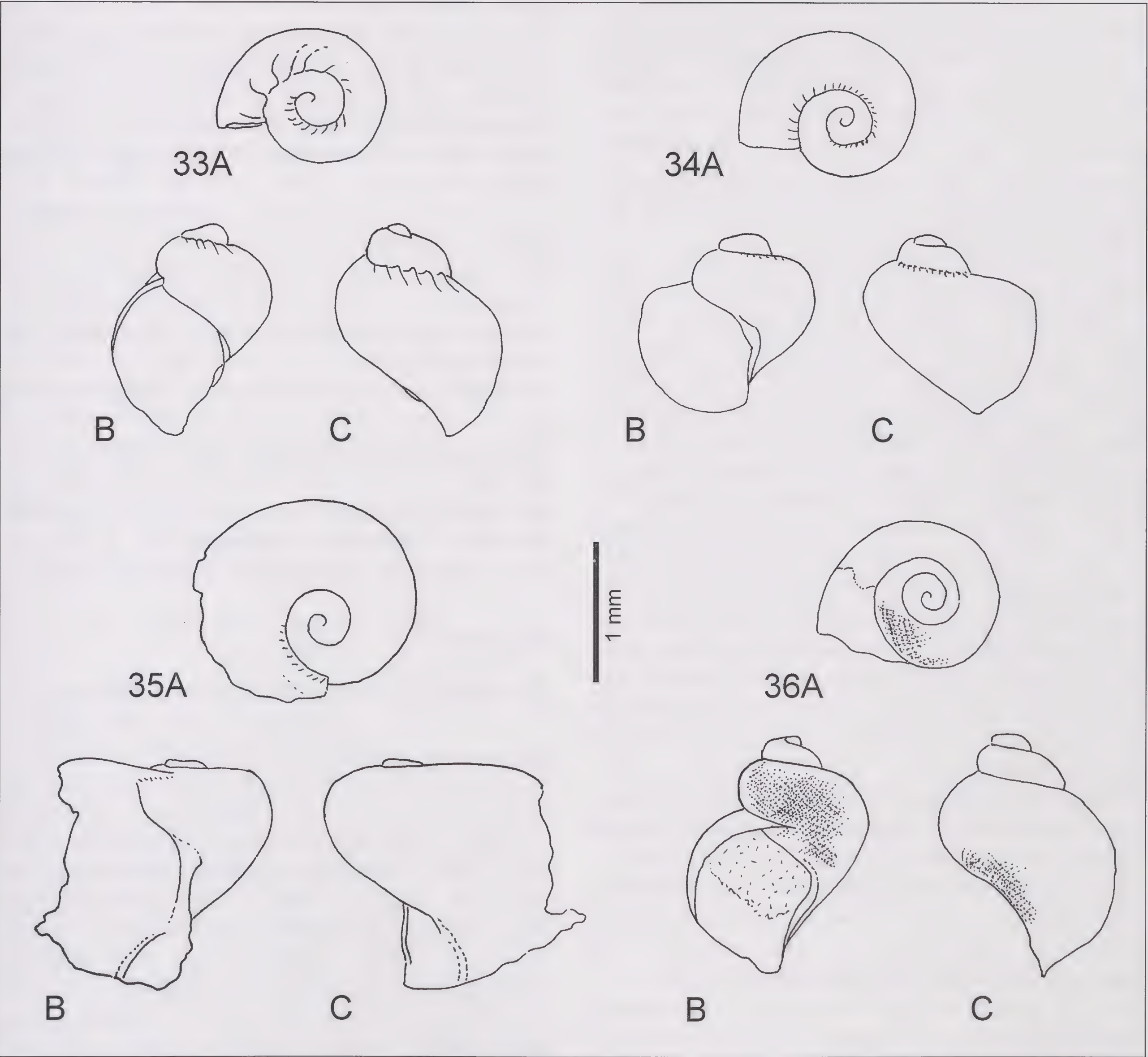
*Peracle bispinosa* (Pelseneer, 1888)  
(Fig. 33A-C)

*Peracelis bispinosa* Pelseneer, 1888: p. 36, pl. 1, figs 9, 10.  
*Peracle diversa*, de Monterosato – Locard, 1897: p. 29, pl. 1, figs 4-6 (non Monterosato).  
*Peracle bispinosa* Pels. – Oberwimmer, 1898: p. 589.  
*Peracelis bispinosa* Pelseneer, 1888 – van der Spoel, 1976: p. 29, fig. 10 (with further synonyms, but exclusive of *P. diversa*).

*Peracelis bispinosa* – Herman, 1981: p. 190.  
*Peracle bispinosa* Pelseneer, 1888 – Gofas et al., 2001p. 200.  
*Peracle bispinosa* Pelseneer, 1888 – Rosenberg, 2009, Malacolog website.  
*Peracle diversa* (Monterosato 1875) – CLEMAM website, 2011 (partim, non Monterosato).  
*Peracelis bispinosa* Pelseneer, 1888a – ETI website, 2011.

Description

See van der Spoel (1976).



**Figs 33-36.** Juvenile *Peracle* species. **Fig. 33A-C.** *Peracle bispinosa* Pelseneer, 1888. Atlantic Ocean, E of midatlantic ridge, 45°21.3' N 27°9.1 W, box-core T90-10B of JGOFS leg-IV expedition, 15 June 1990, water depth 2162 m. Holocene, in upper 43 cms of bottom sediment, with pteropod layers throughout, RGM 570 849. **Fig. 34A-C.** *P. diversa* Monterosato, 1875. East Mediterranean, S of Crete, 34°43.00 N 25°51.60 E to 34°41.60 N 25°49.90 E, water depth 1626-1433 m. Late Holocene to Recent, beam trawl sample of bottom sediment, Meteor 5/1, Sta. 19 Ku, January 17, 1987, RGM 570 850. **Fig. 35A-C.** *P. elata* (Seguenza, 1875). Data as for *P. bispinosa*., RGM 570 855. **Fig. 36A-C.** *P. reticulata* (d'Orbigny, 1835). Data as for *P. diversa*. RGM 570 854. **A.** Apical views. **B.** Ventral views. **C.** Dorsal views. Bar length is 1 mm.

**Figg. 33-36.** Esemplari juvenili di specie del genere *Peracle*. **Fig. 33A-C.** *Peracle bispinosa* Pelseneer, 1888. Oceano Atlantico, ad est della dorsale medioatlantica, 45°21,3' N 27°9,1 O, box-core T90-10B, campagna JGOFS leg-IV, 15 Giugno 1990, profondità 2162 m. Olocene, nei 43 cm superiori del campione di fondo, con vari strati a pteropodi, RGM 570 849. **Fig. 34A-C.** *P. diversa* Monterosato, 1875. Mediterraneo orientale, a sud di Creta, da 34°43,00 N 25°51,60 E a 34°41,60 N 25°49,90 E, profondità 1626-1433 m. Tardo Olocene-Attuale, campione da dragaggio, Meteor 5/1, Stazione 19 Ku, 17 Gennaio 1987, RGM 570 850. **Fig. 35A-C.** *P. elata* (Seguenza, 1875). Dati uguali a quelli di *P. bispinosa*., RGM 570 855. **Fig. 36A-C.** *P. reticulata* (d'Orbigny, 1835). Dati uguali a quelli di *P. diversa*. RGM 570 854. **A.** Viste apicali. **B.** Viste ventrali. **C.** Viste dorsali. Scala = 1 mm.



## Discussion

This species was not recognized with certainty among the many *Peracle* specimens in the present material. A specimen from the central North Atlantic is illustrated in Fig. 33A-C.

Following Tesch (1913) and van der Spoel (1976) the CLEMAM and WoRMS websites still consider *Peracle bispinosa* a synonym of *P. diversa* (see below). The ETI website accepts *P. bispinosa* as a valid species and refers to its distribution as follows: 'Mesopelagic warm water species, restricted to the Atlantic Ocean and Mediterranean Sea, forming a true Atlanto-Mediterranean element (Atlanto-Mediterranean centre)'. With respect to *P. diversa* they state: 'For this species [= *bispinosa*] the name *Peraclis diversa* is available, but the name *Peraclis bispinosa*, in common use, refers to a better description of a full grown specimen. *Peraclis diversa* was first introduced as *nomen nudum* and probably referred to a damaged juvenile shell. For these reasons it is proposed that the priority rule not be used and to suppress the name *Peraclis diversa*. Giovine (1988) is of the opinion that *Peraclis diversa* is a valid species'.

I agree with Giovine (1988) and Gaglini & Villari (1994) that Monterosato (1875: p. 50) introduced the name *Spirialis diversa*, albeit without an illustration, with a short, but rather clear description, distinctly differentiating his new taxon from '*S. reticulata*, d'Orb.' and the name can no way be considered a *nomen nudum*. Also I agree in considering these two taxa valid species. It could be tempting, considering the restricted information available in the current literature, to consider *P. diversa* a juvenile of *P. bispinosa*, as in small specimens of the latter an indication of the subsutural apertural spine is not yet present. Still, a comparison between two specimens of more or less the same size offers discrete differences (Figs 33A-C, 34A-C): juvenile *P. bispinosa* is not only considerably more slender than *P. diversa* with less shouldered whorls, but also has much coarser subsutural crests. I do not doubt that we are dealing with two distinct species.

Oberwimmer (1898) found a dead specimen of this species at three stations in the eastern Mediterranean, but not in the Adriatic. Van der Spoel's (1976, fig. 169) distribution map indicates the presence of this species (but with *P. diversa* included) all over the Mediterranean, the Adriatic Sea excluded. Herman (1981) referred to this species with the following characteristics: '*Peraclis bispinosa* is a meso-bathypelagic species. Rare occurrences have been reported in all basins' (of the Mediterranean). She recorded it from the postglacial part of cores in the Levantine Basin. Rampal (2011) records this species as very rare in the Alboran Sea.

*Peracle diversa* (Monterosato, 1875)  
(Figs 34A-C, 52H-J, 54G)

*Spirialis diversa* Monterosato, 1875: p. 50.

*Spirialis diversa*, Monts – Monterosato, 1878: p. 115.

non *Peracle diversa*, de Monterosato – Locard, 1897: p. 29, pl. 1, figs 4-6 (= *P. bispinosa*).

*Peraclis apicifulva* Meisenheimer, 1906: p. 122, pl. 5, fig. 9a-d.

*Peraclis brevispira* Pelseneer, 1906: p. 146, pl. 12, figs 45-51.

*Peracle apicifulva* Meisenheimer – Colantoni et al., 1970: p. 185, pl. 26, fig. 5a, b.

*Peraclis apicifulva* Meisenheimer – Di Geronimo, 1970: p. 96, pl. 7, fig. 4a-c.

*Peraclis apicifulva* Meisenheimer – Vatova, 1974: p. 110.

*Peraclis apicifulva* Meisenheimer, 1906 – van der Spoel, 1976: p. 30, fig. 11.

*Peraclis apicifulva* (Meisenheimer, 1906) – Almogi-Labin & Reiss, 1977: p. 15, pl. 9, figs 6-7; pl. 10, figs 1-3.

*Peraclis apicifulva* Meisenheimer 1906 – Richter, 1979: p. 22, pl. 4, figs 51, 52.

? *Peraclis* sp. – Buccheri, 1984: p. 80, pl. 1, fig. 4a, b.

non *Peraclis apicifulva* Meisenheimer, 1906 – Grecchi & Bertolotti, 1988: p. 115 (= *P. reticulata*).

*Peracle apicifulva* – Corselli & Grecchi, 1990: p. 97.

*Peracle diversa* Monterosato, 1875 – Gaglini & Villari, 1994: p. 307, pl. 1.

*Peraclis apicifulva* Meisenheimer, 1906 – Kunz, [1996]: p. 149, pl. 25, figs 1-4.

*Peracle diversa* (Monterosato, 1875) – Gofas et al., 2001: p. 200.

*Peracle diversa* (Monterosato, 1875) – Rosenberg, 2009, Malacolog website.

*Peracle diversa* (Monterosato, 1875) – WoRMS website, 2011.

*Peracle apicifulva* Meisenheimer 1906 – CLEMAM website, 2011.

non *Peracle diversa* (Monterosato 1875) – CLEMAM website, 2011 (partim = *P. bispinosa*).

*Peraclis apicifulva* – Rampal, 2011: p. 370, fig. 1-6.

## Description

Van der Spoel (1976), Gaglini & Villari (1994).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 533/29, RGM 570 850 (Fig. 34A-C); Me25-13 Kg1, SMF 332896/1; Me25-15 Kg1, SMF 332923/3; Me25-15 Kg2, SMF 332953/3; Me25-16 Kg1, SMF 332990/4; Me25-16 Kg2, RGM 569 493/1, SMF 333015/4; Me25-17 Kg1, SMF 333040/1; Me25-17 Kg2, SMF 333059/3; Me25-19 Kg2, SMF 333127/1; Me25-20 Kg2, SMF 333167/2; Me25-20 Ku, SMF 333188/1; Me25-21 Kg1, SMF 333209/1; Me25-22 Kg2, SMF 333248/1; Me25-23 Kg1, SMF 333270/1; Me25-24 Kg2, SMF 333339/1; Me25-37 Kg1, RGM 541 630-630a/2 (Fig. 52H-J); Me25-39 Kg1, SMF 333418/3.

Gravity core T98/2/20G, sample 2.24-2.25 m, RGM 569 196/1 (Fig. 54G).

Bologna samples: CJ 72 III-21 (bottom), RGM 570 758/2; CJ 72 III-22, MZB (ex RGM 570 654)/1; CJ 72 III-25 (top), RGM 570 545/7; CR 20, RGM 570 399/1; CR 31, RGM 570 479/2; CR 39, RGM 570 627/23; CR 42, RGM 570 372/5; CR 68, RGM 570 734/21; J 74-9, RGM 570 515/16;



J 74-12, RGM 569 837/1; T74-65-1, RGM 570 959/5 juveniles; T74-65-2, RGM 570 904/1.

## Discussion

This species used to go under the name of *Peracle apicifulva* for a long time. Giovine (1988: p. 24), however, revived Monterosato's name *P. diversa* and considered it a senior synonym of *P. apicifulva*. This was acknowledged by Gaglini & Villari (1994), who relocated syntypes of *Spirialis diversa* Monterosato, 1875, and found them to be identical indeed. Monterosato's name was included with a query among the synonyms of *P. bispinosa* by Tesch (1913: p. 75) and van der Spoel (1976: p. 29). Bedulli et al. (1995: p. 22), the Malacolog website (Rosenberg, 2009) and WoRMS accept *P. diversa* as the valid name. CLEMAM (2011), however, keeps both names as valid, separate species. The ETI (2011) website maintains *P. apicifulva* as the valid name, but refers to the WoRMS website, where it is considered a synonym of *P. diversa*. They consider this latter taxon a senior synonym of *P. bispinosa* (see above).

Rampal (2011) sticks to both *Peraclis* and *P. apicifulva*, without even mentioning the name *P. diversa*. She refers to a single specimen caught alive near Villefranche-sur-Mer. Vatova (1974) recorded this species as 'very rare' and, incorrectly, as '*nuova per il Mediterraneo (Mar Jonio)*' ['new for the Mediterranean (Ionian Sea)'] from three (of four) bottom samples in the Ionian Sea. Corselli & Grecchi (1990), referring to the very few records of living Mediterranean specimens, concluded that a continuous presence of this species in the basin has only been possible in periods with a cooler climate than the present.

### *Peracle elata* (Seguenza, 1875) (Fig. 35A-C)

*Embolus elatus* Seguenza, 1875: p. 148.  
*Embolus elatus*, Seguenza – Seguenza, 1876: p. 47.  
*Embolus triacanthus* Fischer, 1882: p. 49.  
*Protomedeia triacantha*: p. Fischer – Locard, 1897: p. 27, pl. 1, figs 1-3.  
*Limacina triacantha* (Fischer) – Sykes, 1905: p. 328.  
*Peracle triacantha* (Fischer) – Colantoni et al., 1970: p. 184, pl. 26, fig. 6a, b.  
*Peraclis triacantha* (Fischer, 1882) – van der Spoel, 1976: p. 32, fig. 14.  
*Peracle triacantha* (Fischer, 1882) – Nofroni & Silesu, 1986: p. 6, fig.  
*Peraclis reticulata* (d'Orbigny, 1836) – Grecchi & Bertolotti, 1988: p. 114, pl. 1, figs 18 (non d'Orbigny).  
*Peracle triacantha* – Corselli & Grecchi, 1990: p. 96.  
*Embolus elatus* G. Seguenza – Bertolaso & Palazzi, 2000: p. 17, figs 110-112, 178, 179.  
*Peracle triacantha* (Fischer P., 1882) – Gofas et al., 2001: p. 200.  
*Peraclis triacantha* Fischer, 1882) – Janssen, 2004: p. 122, pl. 4, fig. 8.  
*Peracle triacanthus* (P. Fischer, 1882) – Rosenberg, 2009, Malacolog website.

*Peracle triacantha* (Fischer P., 1882) – WoRMS website, 2011.

*Peraclis triacantha* (Fischer, 1882a) – ETI website, 2011.

*Peracle triacantha* (Fischer P. 1882) – CLEMAM website, 2011.

## Description

Van der Spoel (1976), Bertolaso & Palazzi (2000).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 535/1; Me25-16 Kg1, SMF 332992/2; Me25-16 Kg2, SMF 333017/1; Me25-20 Kg1, SMF 333148/1.

Bologna samples: CR 33, MZB (ex RGM 569 804)/2 juveniles; CR 68, RGM 570 736/5.

## Discussion

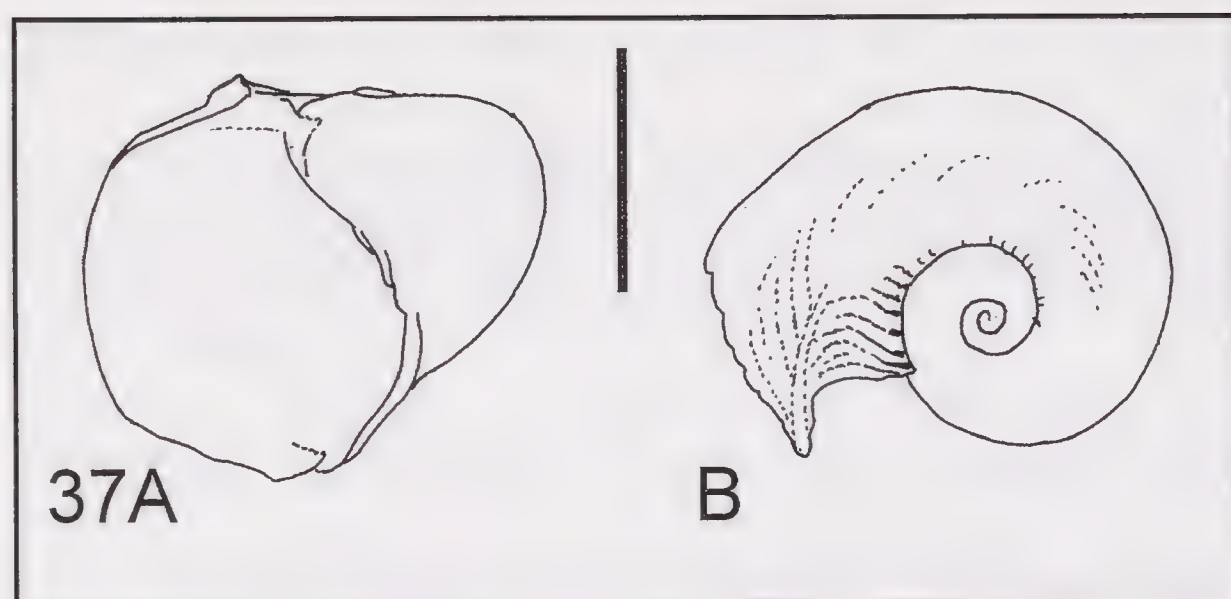
As already implied by Sykes (1905: p. 328) *Embolus elatus* Seguenza, 1875 indeed was found to be a senior synonym of *Embolus triacanthus* Fischer, 1882. The identity could be confirmed by the discovery of two of Seguenza's syntypes in the collections of the Museo di Geologia e Palaeontologia dell'Università di Firenze (Italy) (Bertolaso & Palazzi, 2000). Seguenza (1875) hardly gave any information on his new taxon (no more than '*Apertura grande in rapporto alla spira* [aperture large compared to the spire]'), but a year later (Seguenza, 1876: p. 47) an extensive description was given. The two specimens illustrated in Bertolaso & Palazzi originate from Pliocene deposits near Trapani (Sicily).

The species was recorded from the Pliocene (Piacenzian) of Estepona (Spain) (Janssen, 2004) and is also known from several further Pliocene localities in Italy and France (RGM collections). Corselli & Grecchi (1990), referring to papers by Colantoni et al. (1970) and Nofroni & Silesu (1986), in which specimens were recorded from bottom sediments, do not consider the present species to occur in the living Mediterranean fauna. Rampal (2011) refers to a single find of this species (as *Peraclis triacantha*) in the SW Mediterranean. A juvenile specimen from the N Atlantic is illustrated herein (Fig. 35A-C).

### *Peracle moluccensis* (Tesch, 1903) (Fig. 37A, B)

*Peraclis moluccensis* Tesch, 1903: p. 112.  
*Peraclis moluccensis* Tesch, 1904: p. 16, pl. 1, figs 7-10.  
*Peraclis moluccensis* Tesch, 1903 – van der Spoel, 1976: p. 31, fig. 12 (with further synonymy).  
*Peracle moluccensis* Tesch, 1903 [sic] – Rosenberg, 2009, Malacolog website.  
*Peraclis moluccensis* (Tesch, 1904) [sic] – Rampal, 2011: p. 371, fig. 1-10.  
*Peracle moluccensis* (Tesch, 1903) – WoRMS website, 2011.  
*Peraclis moluccensis* Tesch, 1903 – ETI website, 2011.





**Fig. 37. A, B.** *Peracle moluccensis* (Tesch, 1933). Tyrrhenian Sea, sample T74-95-9; RGM 570 937. **A.** Apertural view. **B.** Apical view. Bar length is 1 mm.

**Fig. 37. A, B.** *Peracle moluccensis* (Tesch, 1933). Mar Tirreno, campione T74-95-9; RGM 570 937. **A.** Vista aperturale. **B.** Vista apicale. Scala = 1 mm.

## Description

See Tesch, 1904, van der Spoel (1976).

## Material examined

Bologna samples: T74-65-9, RGM 570 937/1 (**Fig. 37A, B**).

## Discussion

A single, unmistakable specimen was found in one of the Tyrrhenian Sea samples. In the same sample many specimens of *Limacina retroversa* were present. Rampal (2011) considered the occurrence of this species in the Mediterranean 'peu probable' ['not very probable']. Van der Spoel's (1976) distribution chart for this species shows its presence close to the Strait of Gibraltar, but not in the Mediterranean.

### *Peracle reticulata* (d'Orbigny, 1834) (Figs 36A-C, 53A, B)

*A[llanta] reticulata* d'Orbigny, 1834: pl. 12, figs 32-35, 39.  
*Atlanta* (*Heliconoides*) *reticulata*, d'Orb. – d'Orbigny, 1836: p. 178.

*Peracle reticulata* Pels. – Oberwimmer, 1898: p. 589 (non Pelseneer).

*Peraclis reticulata* (Orb.) – van Straaten, 1966: p. 431.

*Peraclis reticulata* (d'Orbigny) – Di Geronimo, 1970: p. 94, pl. 7, fig. 3a, b.

*Peracle reticulata* (Orb.) – Colantoni et al., 1970: p. 184, pl. 26, fig. 4.

? *Peraclis* sp. – Herman, 1971a: p. 617, 618.

*Peraclis reticulata* (d'Orbigny) – Vatova, 1974: p. 110.

? *Spiratella lesueurii* Orbigny 1836 – Nordsieck, 1973: p. 6, fig. 20 (non *lesueurii* d'Orbigny, 1835).

*Peracle reticulata* (Orbigny) 1838 [sic] – Nordsieck, 1973: p. 6, fig. 23.

*Peraclis reticulata* (d'Orbigny, 1836) – van der Spoel, 1976: p. 28, fig. 9 (with extensive synonymy).

*Peraclis reticulata* (d'Orbigny, 1836) – Almogi-Labin & Reiss, 1977: p. 15, pl. 10, figs, 5-6.

*Peraclis reticulata* – Herman, 1981: p. 190.

*Peraclis apicifulva* Meisenheimer, 1906 – Grecchi, 1984: p. 18, pl. 1, figs 10, 11, 17 (non Meisenheimer).

*Peraclis reticulata* (d'Orbigny, 1836) – Grecchi & Bertolotti, 1988: p. 114, pl. 1, figs 19, 20 (non fig. 18 = *P. elata*).

*Peraclis apicifulva* Meisenheimer, 1906 – Grecchi & Bertolotti, 1988: p. 115, pl. 1, figs 14, 15 (non Meisenheimer).

*Peracle reticulata* (d'Orbigny, 1836) – Gofas et al., 2001: p. 200.

*Peracle reticulata* (d'Orbigny, 1834) – Rosenberg, 2009, Malacolog website.

*Peraclis reticulata* (d'Orbigny, 1836) – ETI website, 2011.

*Peracle reticulata* (d'Orbigny, 1836) – WoRMS website, 2011.

*Peracle reticulata* (d'Orbigny 1836: *Atlanta*) – CLEMAM website, 2011.

## Description

See van der Spoel (1976).

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 534/many, RGM 570 854/1 (**Fig. 36A-C**); Me25-11 Kg1, SMF 332871/1; Me25-12 Kg2, SMF 332880/1; Me25-13 Kg1, SMF 332897/5; Me25-13 Kg2, SMF 332911/2; Me25-15 Kg1, SMF 332934/11; Me25-15 Kg2, SMF 332954/6; Me25-15 Ku, SMF 332970/1; Me25-16 Kg1, SMF 332991/38; Me25-16 Kg2, RGM 569 494/5, SMF 333016/15; Me25-17 Kg1, SMF 333041/22; Me25-17 Kg2, SMF 333060/23; Me25-18 Kg1, SMF 333074/7; Me25-18 Kg2, SMF 333091/1; Me25-19 Kg1, SMF 333108/19; Me25-19 Kg2, SMF 333128/15; Me25-20 Kg1, SMF 333147/7; Me25-20 Kg2, SMF 333168/5; Me25-20 Ku, SMF 333189/8; Me25-21 Kg1, SMF 333210/11; Me25-21 Kg2, SMF 333228/28; Me25-22 Kg2, SMF 333249/7; Me25-23 Kg1, SMF 333271/19; Me25-23 Kg2, SMF 333289/19; Me25-23 Ku, SMF 333307/7; Me25-24 Kg1, SMF 333322/5; Me25-24 Kg2, SMF 333340/14; Me25-37 Kg1, RGM 541 631/32; Me25-37 Ku, SMF 333369/9; Me25-38 Kg1, SMF 333387/21; Me25-38 Ku, SMF 333401/4; Me25-39 Kg1, SMF 333419/3; Me25-39 Kg2, SMF 333436/2.

Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 076/1 (Saalian).

Gravity core T87/2/20G, sample 2.45-2.46 m, 2.42-2.43 m, RGM 569 114b/14; RGM 569 099/1; 2.36-2.37 m, RGM 569 137/3, RGM 569 138b/4; 2.33-2.34 m, RGM 569 159/2; 2.30-2.31 m, RGM 569 173/4, RGM 569 174d/2; 2.24-2.25 m, RGM 569 194/15, RGM 569 195a/4, RGM 569 194a, c/2 (**Fig. 53A, B**); 2.21-2.22 m, RGM 569 216/5, RGM 569 217b/7; 2.18-2.19 m, RGM 569 232/1, RGM 569 233b/3; 2.03-2.04 m, RGM 569 276/4; 1.97-1.98 m, RGM 569 286b/2; 1.91-1.92 m, RGM 569 295/4; 1.72-1.73 m, RGM 569 308/1 (Eemian).

Gravity core T87/2/20G, sample 0.05-0.06 m, RGM 569 399/1 (Holocene).

Bologna samples: CJ 72 III-21, RGM 570 458/4; CJ 72 III-21 (bottom), RGM 570 757/11 juveniles; CJ 72 III-22, MZB (ex RGM 570 655)/2 juveniles; CJ 72 III-25 (top),



RGM 570 546/8; CJ 72 III-27 (centre), RGM 570 704/2; CR 20, RGM 570 400/5; CR 31, RGM 570 480/5; CR 33, MZB (ex RGM 569 803)/11; CR 34, RGM 570 682/6; CR 39, RGM 570 628/many; CR 42, RGM 570 373/35; CR 68, RGM 570 735/many; CR 70, RGM 570 574/5 juveniles; J 74-9, RGM 570 516/1, many juveniles, RGM 570 597/1; J 74-10, RGM 569 919/1 juvenile; J 74-12, RGM 569 838/9 juveniles; T74-55-6, RGM 570 925/2 juveniles; T74-65-1, RGM 570 960/16 juveniles; T74-65-2, RGM 570 905/8 juveniles.

## Discussion

Fully grown specimens of *Peracle reticulata* are easily recognized by their shape and frequently preserved light brownish colour. Very juvenile shells, however, resemble especially *P. diversa* closely. A clear difference is the absence of subsutural crests in *P. reticulata*.

This species was recorded by Oberwimmer (1898) from a number of stations in the eastern Mediterranean Sea, all from bottom samples. He did not find this species in the Adriatic.

Herman (1971a, 1981) recorded '*Peraclis* sp.' from post-glacial and/or interstadial parts of cores in the Levantine Basin, as well as from the southern Aegean and Ionian seas. For *P. reticulata* she stated that it is found in all basins at low frequencies. Vatova (1974) encountered this species rather rare in three of four bottom samples of the Ionian Sea. Rampal (2011) found this species to occur frequently in the eastern Mediterranean and the Alboran Sea. Many further authors recorded this species from the Mediterranean basin, dead or alive.

### *Peracle?* sp.

(Figs 38, 53C-J, 54A-F)

*Peraclis reticulata* (d'Orbigny, 1836) – Kunz, [1996]: p. 143, pl. 23, fig. 4 (reproduced herein as Fig. 38) (partim, non pl. 23, figs 1-3 = *P. reticulata*).

## Description

Very small sinistral shells ( $H = \sim 300 \mu\text{m}$ ), of barely more than one whorl that very rapidly increases in diameter. Juveniles are wider than high, but the largest specimens are almost as high as wide. The nucleus is comparatively large (diameter c.  $115\text{--}120 \mu\text{m}$ ), spherical and covered with a polygonal ornament (Figs 53J, 54C, F), only visible in SEM-imaging. The upper apertural margin reaches higher than the initial parts of the shell (Fig. 53C, E, I). The aperture is roundish to broadly elliptical; columella and umbilicus are covered with matrix in most specimens. There are no apertural reinforcements.

## Material examined

Gravity core T87/2/20G, 2.36-2.37 m, RGM 569 138a/14; 2.33-2.34 m, RGM 569 160/21, RGM 569 160a-d/4 (Fig. 53C-H); 2.30-2.31 m, RGM 569 174/13, RGM 569 174a-



Fig. 38. *Peracle?* sp. Southern Red Sea, plankton catch. After Kunz (1996: pl. 23, fig. 4).

Fig. 38. *Peracle?* sp. Mar Rosso meridionale, retinata di plancton. Da Kunz (1996: pl. 23, fig. 4).

c/3 (Fig. 53I, J, 54A-F); 2.24-2.25 m, RGM 569 195b/13, 2.21-2.22 m, RGM 569 217a/11; 2.18-2.19 m, RGM 569 233a/3; 2.16-2.17 m, RGM 569 245/4; 2.14-2.15 m, RGM 569 261/1; 1.97-1.98 m, RGM 569 286a/1 (Eemian).

Gravity core T87/2/20G, 0.25-0.26 m, RGM 569 361/11 (Weichselian).

Gravity core T87/2/20G, sample 0.12-0.13 m, RGM 569 379/21 (sample lost); 0.11-0.12 m, RGM 569 386/7; 0.05-0.06 m, RGM 569 400/6 (Holocene).

Bologna samples: CJ 72 III-21 (bottom), RGM 570 759/3; CJ 72 III-25 (top), RGM 570 547/17; CR 20, RGM 570 401/5; CR 33, MZB (ex RGM 569 805)/7; CR 34, RGM 570 683/14; CR 39, RGM 570 629/20; CR 42, RGM 570 374/30; CR 68, RGM 570 737/15; CR 70, RGM 570 575/20; J 74-9, RGM 570 517/many; J 74-10, RGM 569 920/16; J 74-12, RGM 569 839/14; T74-55-6, RGM 570 926/18; T74-65-1, RGM 570 961/31; T74-65-2, RGM 570 906/11.

## Discussion

The discovery of an as yet unknown larval shell of a holoplanktonic species in an area so well investigated as the Mediterranean is, to say the least, surprising. As far as I have been able to establish the present species has only once been referred to in literature (Kunz, 1996; his nice SEM image of a specimen caught alive is reproduced here in Fig. 38), albeit erroneously identified as *Peracle reticulata*. In all probability it is because of the very small dimensions that this species has not been noted before. Still, it is a not very rare occurrence, as is clear from the 'material examined' listing, above.

This species is assigned to the genus *Peracle* with hesitation, but the peculiar ornament of the nucleus was also demonstrated, albeit less strongly developed, to occur in other *Peracle* species by Kunz and is unknown in



other Pseudothecosomata species. Once metamorphosis of living specimens will be observed this genus assignment might be reviewed.

In the present state of knowledge it cannot be excluded that these are the larval shells of, for instance, *Desmopterus papilio* (see above), but there is not the slightest indication to be found in literature acknowledging this. The observation of Kunz (1996) demonstrates that this species still lives in the southern Red Sea, from where, by the way, *Desmopterus papilio* is also recorded (van der Spoel, 1976, fig. 184). Should it be demonstrated that this indeed is the larval shell of *Desmopterus papilio*, then this species does certainly NOT belong to the Gymnosomata, as was sometimes suggested (see above), because a sinistrally spiralised embryonic shell is not known to occur in gymnosomes.

From all other *Peracle* species the present one differs by its unusual small size, extremely rapidly widening body whorl and the strong polygonal ornament on the relatively large and spherical nucleus. Specimens were collected most abundantly from the Eemian and in lower numbers from the Weichselian and Holocene intervals of core T87/2/20G, and also in several of the Bologna bottom samples.

Clade Gymnosomata de Blainville, 1824  
Superfamily Clionoidea Rafinesque, 1815  
Family Pneumodermatidae Pelseneer, 1887

Note: Living specimens of *Pneumoderma mediterraneum* (van Beneden, 1838) were recorded as not common near Nice by Vérany (1853: p. 381). Steuer (1911: p. 728) refers to observations by Meisenheimer (1905) and Grandori (1910) of Adriatic specimens of that species. The Mediterranean occurrence is acknowledged by van der Spoel (1976: fig. 203), who excludes the extreme eastern part of the basin.

Steuer (1911: p. 728) recorded a specimen of *Pneumoderma ciliata* (Gegenbaur, 1855) from the Adriatic. Van der Spoel (1976: fig. 187) includes the complete Mediterranean Sea in the distribution pattern of this species.

Family Clionidae Rafinesque, 1815

Note: ICZN (2006) has ruled that homonymy between the family names Clionidae Rafinesque, 1815 (Mollusca) and Clionidae d'Orbigny, 1851 (Porifera) is removed by changing the spelling of the junior homonym, and that the entire generic name *Cliona* Grant, 1826 (Porifera) is used to form the name Clionaidae, leaving the stem of the senior homonym (based on the name *Clione* Pallas, 1774, Mollusca) unchanged. See also Bouchet & Rützler (2003) and Willan et al. (2004).

## Discussion

Lalli & Conover (1976) described the development of gymnosomatous larvae of *Paedoclione doliiformis* Danforth, 1907 and *Clione limacina* (Phipps, 1774) under laboratory conditions and observed the various stages of the larval shells. They described two distinctly differ-

ent shell areas, indicated as 'embryonic shell' and 'postembryonic shell'. A postlarval shell, or teleoconch, according to these authors, is absent. In the two species extensively described by them only these two shell portions occur, but in at least two of the species encountered in the present material (Genus Clionidarum sp. 1 and sp. 2) a threefold development can be distinguished. The 'embryonic shell', formed in the egg, is here indicated as protoconch-1 and the following shell-part, collar-shaped in the two species mentioned, is indicated as protoconch-2. The postlarval shell, because of the presence of distinct growth lines I indicate as 'early teleoconch', although obviously this shell part is already formed before metamorphosis of the larva (and see also the discussion below under 'beaked larva'). A well-developed real teleoconch is absent in Gymnosomata.

An extensive motivation for the use of the expression 'Genus Clionidarum', to be considered a name for a 'collective group' as meant in art. 1.2.1, 10.3 and 42.2.1 ICZN (1999), is given in Janssen (in press). In that paper on Oligo-Miocene deposits of the central Mediterranean, six new gymnosomatous species are introduced, based on larval shells only. I hesitate, however, to do the same in the present study. As the age of all specimens is late Quaternary at the most it is almost certain that the various gymnosomatous larval shells referred to herein belong to extant species that are exclusively known as adult, shell-less specimens. Actually, however, there is no possibility to decide which larval shell type belongs to which of the many described species. So, as argued before, I maintain the indication 'Genus Clionidarum' and suggest to keep the numbering initiated herein as a starting point for the indication of future finds of Quaternary-Recent shells, until ultimately biologists succeed in assigning the larval shells to the adults.

## Genus Clionidarum sp. 1 (Fig. 55A-F)

Fünfte Larvenart – Krohn, 1860: p. 12, pl. 1, figs 7, 8.

? *Euclio polita* (Pelseneer) – Menzies, 1958: p. 384, fig. 2e, f (non Pelseneer).

? *Clio polita* Pelseneer – Vergnaud Grazzini & Herman Rosenberg, 1969: p. 280, tab. 1 (non Pelseneer).

? *Clio polita* Pelseneer – Herman, 1971a: p. 614, 618 (non Pelseneer).

*Clio polita* – Herman, 1971b: p. 475ff (non Pelseneer).

? *Clio polita* – Torelli & Buccheri, 1981: p. 178 (non Pelseneer).

*Paedoclione doliiformis* Danforth, 1907 – Grecchi, 1987: p. 299, figs 1, 2 (non Danforth).

*Paedoclione doliiformis* Danforth, 1907 – Grecchi & Bertolotti, 1988: p. 117, pl. 1, fig. 16, 17 (non Danforth).

*Clio polita* – Corselli & Grecchi, 1990: p. 93 (non Pelseneer).

Gymnosomata Typ 1 – Kunz, [1996]: p. 170, pl. 32, fig. 1 (partim, non fig. 2).

Gymnosomata sp. 1 – Janssen, 2007: p. 164, pl. 24, figs 4-7; pl. 25, fig. 1.

Gymnosomata sp. – Janssen, 2007b: p. 106, pl. 25, fig. 9.



## Description

This species is characterized by a globose, dorso-ventrally slightly compressed protoconch-1, elliptical in shape with a rounded tip and no surface ornament or growth lines. After a clear constriction in which short vertical crests are developed a somewhat swollen and collar-shaped protoconch-2 follows on which very vague growth lines start to develop. This part is separated from an early teleoconch by a less clearly marked constriction. On this latter shell part distinct growth lines are present and a fine longitudinal ornament, consisting of very fine incised, slightly irregular lines. Height of these specimens is a bit variable but fluctuates between 230 and 270  $\mu\text{m}$  in specimens with a well-developed early teleoconch as illustrated in Fig. 55A-F, width of protoconch-1 is more constant around 155-170  $\mu\text{m}$  with a transverse diameter of 135-150  $\mu\text{m}$ .

## Material examined

Box core and beam trawl samples: Me 5/1, 19Ku, RGM 569 536/1.

Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 077/2 (Saalian).

Gravity core T87/2/20G, sample 2.785-2.795 m, RGM 569 083/5; 2.36-2.37 m, RGM 569 142/1; 2.33-2.34 m, RGM 569 161/1; 2.24-2.25 m, RGM 569 199/1; 2.21-2.22 m, RGM 569 221/5; 2.18-2.19 m, RGM 569 238/21; 2.16-2.17 m, RGM 569 249/29; 2.14-2.15 m, RGM 569 259/8; 2.14-2.15 m, RGM 569 269/3; 2.03-2.04 m, RGM 569 280/21; 1.97-1.98 m, RGM 569 289/15; 1.91-1.92 m, RGM 569 298/1; 1.79-1.80 m, RGM 569 301/1; 1.72-1.73 m, RGM 569 3051/1; 1.72-1.73 m, RGM 569 311/16; 1.68-1.69 m, RGM 569 321/34, RGM 569 321a, b /2, RGM 569 321c-f/4 (Fig. 55A-F); 1.61-1.62 m, RGM 569 327f/1; 1.60-1.61 m, RGM 569 328d/2 (Eemian).

Gravity core T87/2/20G, sample 0.25-0.26 m, RGM 569 362/11; 0.22-0.23 m, RGM 569 366m/7; 0.20-0.21 m, RGM 569 3671/3; 0.19-0.20 m, RGM 569 368k/1; 0.17-0.18 m, RGM 569 371/13; 0.16-0.17 m, RGM 569 374j/3; 0.14-0.15 m, RGM 569 375n/7; 0.12-0.13 m, RGM 569 381/11; 0.05-0.06 m, RGM 569 403/2 (Holocene).

Bologna samples: CJ 72 III-20, RGM 570 418/28; CJ 72 III-21 (bottom), RGM 570 761/22; CJ 72 III-22, MZB (ex RGM 570 656)/2; CJ 72 III-25 (top), RGM 570 548/6; CJ 72 III-27 (centre), RGM 570 705/many; CR 33, MZB (ex RGM 569 806)/3; CR 42, RGM 570 375/20; CR 68, RGM 570 738/2; CR 70, RGM 570 576/6; J 74-9, RGM 570 518/many; J 74-10, RGM 569 921/13; J 74-12, RGM 569 840/8; T74-55-6, RGM 570 926/18; T74-65-1, RGM 570 962/many (>100); T74-65-2, RGM 570 907/23.

## Discussion

Specimens of Genus *Clionidarum* sp. 1 were repeatedly recorded from the Mediterranean and considered to represent protoconchs of the pteropod *Clio polita*. Such records were all re-identified as *Paedoclione doliiformis* Danforth, 1907, by Grecchi (1987) and Corselli & Grec-

chi (1990: p. 93), based on the papers of Lalli & Conover (1973, 1976). Unfortunately, this cannot be correct, as adult specimens of that species are unknown from the Mediterranean. *Paedoclione doliiformis* has a very restricted geographical distribution, limited to the NW Atlantic off Connecticut (van der Spoel, 1976, fig. 220). Additionally, there is a distinct morphological difference between shells of that species and the Mediterranean/Red Sea material. The larval shell of *P. doliiformis*, one of the very few that is identified specifically, differs from Genus *Clionidarum* sp. 1 by the absence of the collar-shaped protoconch-2. Growth lines develop right after the constriction and a longitudinal microornament is present (Lalli & Conover, 1976, figs 5, 6).

Genus *Clionidarum* sp. 2 resembles the present species closely but differs constantly in its dimensions (see below). Specimens from the Red Sea area described by Kunz (1996) and Janssen (2007a) are completely identical. The same species was also collected in bottom samples from the central North Atlantic (RGM collection). Herman (1971a, b) mentioned most probably this species (as *Clio polita*) in low numbers from postglacial sediments in the Levantine Basin. The specimen illustrated by Menzies (1958) most probably belongs to the present species, as it is the most common one occurring in bottom sediments. The primitive drawing, however, does not exclude the possibility that in fact the next species was encountered.

Corselli & Grecchi (1990: p. 93) acknowledged the fact that the species frequently recorded as *Clio polita* in reality belongs to the Gymnosomata and was also mentioned under the name of *Paedoclione doliiformis*.

### Genus *Clionidarum* sp. 2 (Fig. 55G-K)

*Clio polita* (MS Craven) Pelseneer, 1888 – Almogi-Labin & Reiss, 1977: p. 9, pl. 1, fig. 9, pl. 2, figs 2-5 (non Pelseneer).

*Clio polita* (ms. Craven)(Pelseneer) – Buccheri & di Stefano, 1984: p. 182, pl. 1, fig. 6 (non Pelseneer).

Protoconch of unknown gymnosomatous pteropod – Biekart, 1989: pl. 1, fig. 3.

## Description

This species resembles Genus *Clionidarum* sp. 1 closely, but differs by its larger dimensions ( $H = 275\text{--}320\ \mu\text{m}$ ,  $W = 195\text{--}235\ \mu\text{m}$ , dorso-ventral diameter =  $170\text{--}175\ \mu\text{m}$ ). The two species are distinctly separated and easily distinguished when co-occurring in a larger sample. Another difference is found in the longitudinal ornament of the early teleoconch, built up from very fine, irregular lirae, contrary to the incised lines as seen in Genus *Clionidarum* sp. 1. This latter difference, however, is only visible in SEM-images.

## Material examined

Gravity core T87/2/20G, sample 2.47-2.48 m, RGM 569



096/3; 2.42-2.43 m, RGM 569 112/6; 2.36-2.37 m, RGM 569 143/3; 2.33-2.34 m, RGM 569 162/4, RGM 569 162a/1 (Fig. 55G); 2.30-2.31 m, RGM 569 178/6; 2.24-2.25 m, RGM 569 200/7, RGM 569 200a, b /2 (Fig. 55H-J); 2.21-2.22 m, RGM 569 222/2; 2.18-2.19 m, RGM 569 239/2; 2.16-2.17 m, RGM 569 250/4; 2.14-2.15 m, RGM 569 260/2; 2.03-2.04 m, RGM 569 281/2; 1.91-1.92 m, RGM 569 299/2; 1.79-1.80 m, RGM 569 302/1; 1.76-1.77 m, RGM 569 304f/1; 1.68-1.69 m, RGM 569 322/2; 1.65-1.66 m, RGM 569 325/2 (Eemian).

Gravity core T87/2/20G, sample 1.43-1.44 m, RGM 569 332j/1; 0.55-0.56 m, RGM 569 351d/1; 0.45-0.46 m, RGM 569 353d/1; 0.25-0.26 m, RGM 569 363/1 (Weichselian).

Gravity core T87/2/20G, sample 0.18-0.19 m, RGM 569 369n/2; 0.17-0.18 m, RGM 569 372/2; 0.12-0.13 m, RGM 569 382/1; 0.05-0.06 m, RGM 569 404/3, RGM 569 404a/1 (Fig. 55K) (Holocene).

Bologna samples: CJ 72 III-20, RGM 570 419/15; CJ 72 III-21 (bottom), RGM 570 760/3; CJ 72 III-22, MZB (ex RGM 570 657)/1; CJ 72 III-25 (top), RGM 570 549/7; CJ 72 III-27 (centre), RGM 570 706/5 (sample lost); CR 33, MZB (ex RGM 569 807)/2; CR 39, RGM 570 630/1; CR 70, RGM 570 577/9; J 73-29, RGM 570 441/1; J 74-9, RGM 570 519/many; J 74-12, RGM 569 841/2; T74-55-6, RGM 570 927/2; T74-65-1, RGM 570 963/35; T74-65-2, RGM 570 908/11.

## Discussion

'Gymnosomata Typ 1', as illustrated by Kunz (1996: p. 170, pl. 32, fig. 2) from the Red Sea, resembles the present species, but remains smaller ( $H = 235 \mu\text{m}$ ) and the early teleoconch part bears very regular annulations crossed by similar irregular radial lirae as in *Genus Clionidarum* sp. 2. Specimens illustrated by Almogi-Labin & Reiss (1977) from sediment samples and cores taken along the coast of Israel, obviously represent this species, as is clear from the radial ornament on the teleoconch.

### Genus *Clionidarum* sp. 3 (Fig. 56A-C)

Dritte Larvenart – Krohn, 1860: p. 10, pl. 1, fig. 5.

Gymnosomata Typ II – Kunz, [1996]: p. 172, pl. 32, fig. 3 (non fig. 4 = Genus *Clionidarum* sp. 4).

## Description

Conical shells consisting of an ovoid protoconch-1 and an elongate early teleoconch, with an apical angle of c.  $12-17^\circ$  (average of  $14.5^\circ$ ,  $n = 20$ ). Large specimens reach a shell height of  $600 \mu\text{m}$  and a width at the aperture of  $200 \mu\text{m}$ . The boundary between protoconch-1 and the early teleoconch is formed by a clear, but not very deep constriction, after which growth lines start. Height of protoconch-1 varies between  $120$  and  $140 \mu\text{m}$  and its width between  $100$  and  $120$  ( $145$ )  $\mu\text{m}$ , the latter value reached by a single specimen only. The transverse diameter of the shell is circular all over its height. On the younger parts of the early teleoconch a microornament

of very fine lirae is present (Fig. 56B), the number of lirae increasing towards the apertural margin.

## Material examined

Box core samples: Me51/3-562, DCS RGA511/2?

Gravity core T87/2/20G, sample 2.81-2.82 m, RGM 569 078/1 (Saalian).

Gravity core T87/2/20G, sample 2.785-2.795 m, RGM 569 084/1; 2.42-2.43 m, RGM 569 113/3; 2.36-2.37 m, RGM 569 144/16; 2.33-2.34 m, RGM 569 163/2, RGM 569 163a, b /2 (Fig. 56A-C); 2.30-2.31 m, RGM 569 179/8; 2.24-2.25 m, RGM 569 201/5, RGM 569 301a-c/3; 2.21-2.22 m, RGM 569 223/1; 2.18-2.19 m, RGM 569 240/5, RGM 569 240a/1; 2.16-2.17 m, RGM 569 251/1; 1.97-1.98 m, RGM 569 290/1 (Eemian).

Gravity core T87/2/20G, sample 1.03-1.04 m, RGM 569 337e/1; 0.30-0.31 m, RGM 569 356h/1; 0.25-0.26 m, RGM 569 364/1 (Weichselian).

Gravity core T87/2/20G, sample 0.05-0.06 m, RGM 569 405/1 (Holocene).

Bologna samples: CJ 72 III-27 (centre), RGM 570 707/16; J 74-9, RGM 570 520/25.

## Discussion

The present specimens essentially resemble the larval shell of *Clione limacina*, as illustrated by Lalli & Conover (1976, figs 7, 8), but differ by another shape of the early teleoconch: elliptical in transverse section in *C. limacina*, but circular in the present species, in which also the height of the early teleoconch reaches considerably larger dimensions. Furthermore the early teleoconch has a distinctly smaller apical angle. *Clione limacina*, according to van der Spoel (1976, fig. 221), is only present in the westernmost parts of the Mediterranean. Specimens resembling larval shells of that species were indeed not recognized in the present samples. Very similar, if not identical specimens were isolated from a bottom sample, collected in the central North Atlantic (coll. RGM 515 607).

### Genus *Clionidarum* sp. 4 (Fig. 56D, E)

*Cuvierina* cf. *columnella* (Rang, 1827) – Grecchi & Bertolotti, 1988: p. 110, pl. 1, fig. 11 (non Rang).

Gymnosomata Typ II – Kunz, [1996]: p. 170, pl. 32, fig. 4 (partim, non fig. 3 = Genus *Clionidarum* sp. 3).

Gymnosomata Typ IIa sensu Kunz (1996) – Janssen, 2007a: p. 165, text-fig. 7 (after Kunz).

## Description

Larval shell ( $H = 455 \mu\text{m}$ ,  $W$  at aperture =  $185 \mu\text{m}$ ) consisting of two clearly separated parts: a spherical, unornamented protoconch-1, followed by a conical early teleoconch. The boundary between these parts is a distinct constriction ( $W = 93 \mu\text{m}$ ). Protoconch-1 is incompletely preserved, but in the specimen illustrated by



Grecchi & Bertolotti (1988) the diameter is 140  $\mu\text{m}$ , whereas Kunz (1996: p. 173) indicates a diameter of only 85  $\mu\text{m}$  for a specimen from the Red Sea. What remains of protoconch-1 in the specimen illustrated herein has a diameter of 117  $\mu\text{m}$ . Its early teleoconch is conical, with an apical angle of 17° and a circular transverse section. Rather regular transverse, slightly curved annulations become more clearly developed towards the aperture. Slightly irregular longitudinal lirae (Fig. 56E) develop from the constriction upwards, covering the lower one third part of the early teleoconch.

## Material examined

Gravity core T87/2/20G, 2.21-2.22 m, RGM 569 224/1 (Fig. 56D, E) (Eemian).

Bologna samples: J 74-9, RGM 570 598/2.

## Discussion

Krohn (1860: pl. 1, figs 1, 4) illustrated two different types of gymnosomatous larval shells that basically resemble the present specimens, but differ in details. In his fig. 1 he illustrated a so-called 'Erste Larvenart', with a shell height of 1125  $\mu\text{m}$ , a spherical protoconch-1, no clearly indicated protoconch-2 and a slender, regularly annulated early teleoconch. No radial ornament is indicated. The other species, Krohn's fig. 4, with a query indicated as 'Zweite Larvenart' also has a spherical protoconch-1, followed by a longitudinally striated, collar-shaped protoconch-2, after which an early teleoconch is developed with a much wider apical angle than in the first type, and very fine and regular transverse striation. Both these types differ from the present specimens.

Grecchi & Bertolotti (1988) found 34 specimens of the present species, erroneously identified as *Cuvierina* cf. *columnella*, in Holocene and late Pleistocene samples of core GC-18 (32° 32' 83" N 26° 50' 49" E), both in intervals considered as 'cold' and 'warm'.

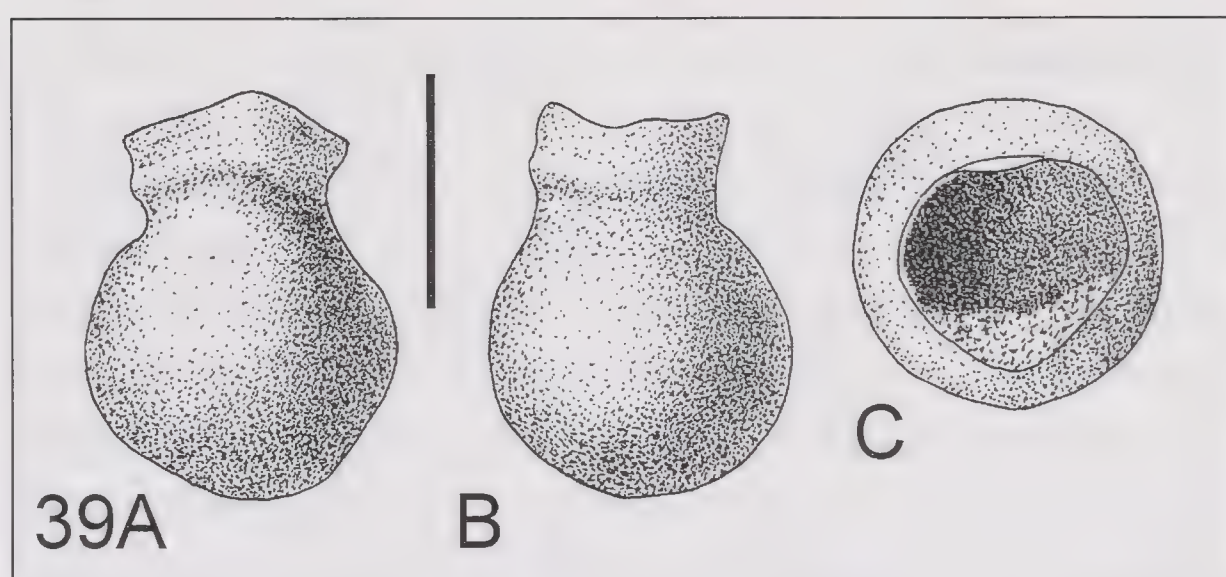
### Genus *Clionidarum* sp. 5 (Fig. 39A-C)

## Description

Very small larval shell (H c. 150  $\mu\text{m}$ , W and dorso-ventral diameter c. 110-115  $\mu\text{m}$ ) of not quite regular, spherical shape. A distinct constriction (W = 65  $\mu\text{m}$ ) separates a short early teleoconch on which vague growth lines are seen and, only in the illustrated specimen (Fig. 39A-C), a low transverse swelling. The sides of the early teleoconch enclose an angle of about 60°. The aperture (W = c. 80  $\mu\text{m}$ ) is irregularly circular to almost pentagonal. The central part of the apertural margin (in supposed dorsal view, Fig. 39A) is slightly produced.

## Material examined

Bologna samples: CR 39, RGM 570 631/1; J 74-9, RGM 570 599/14, RGM 570 599a/1 (Fig. 39A-C).



**Fig. 39. A-C.** Genus *Clionidarum* sp. 5. Bologna-sample J74-9, Ionian Sea; RGM 570 599a. **A.** Dorsal view. **B.** Right lateral view. **C.** Apertural view (a remnant of matrix is still sticking in the aperture). Bar length is 100  $\mu\text{m}$ .

**Fig. 39. A-C.** Genus *Clionidarum* sp. 5. Campione di Bologna J74-9, Mar Ionio; RGM 570 599a. **A.** Vista dorsale. **B.** Vista laterale destra. **C.** Vista aperturale (residui di sedimento sono ancora presenti all'interno dell'apertura). Scala = 100  $\mu\text{m}$ .

## Discussion

To my knowledge nothing similar has ever been published. I have been hesitating to consider it a gymnosome larval shell and not, for instance, crustacean eyes or so. The basic similarity, however, with the other gymnosomatous larval shells is striking: absence of ornament on the spherical part, distinct constriction, appearance of growth lines on the early teleoconch and also an extremely thin shell wall.

### Clade *incertae sedis*

'Beaked larvae' *sensu* van der Spoel & Newman, 1990  
(Fig. 56F-J)

*Creseis chierchiae* Boas – Menzies, 1958: p. 386, fig. 2C, D (not 2E) (non Boas).

*Creseis chierchiae* (Boas)? – Magaldi, 1977: p. 305, pl. 2, fig. 20 (non Boas).

*Creseis chierchiae* – Corselli & Grecchi, 1990: p. 99 (non Boas).

Beaked larva – van der Spoel & Newman, 1990: p. 207, figs 5a-d.

'Beaked larvae' *sensu* van der Spoel & Newman, 1990 – Janssen, 2007a: p. 190, pl. 24, fig. 8a, b.

## Description

Van der Spoel & Newman (1990).

## Material examined

Gravity core T87/2/20G, sample 2.36-2.37 m, RGM 569 145/2 fragments, RGM 569 145a/1 fragment (Fig. 56G), RGM 569 145b/1 fragment (Fig. 56F); 2.33-2.34 m, RGM 569 164/2, RGM 569 164a/1 (Fig. 56H, I); 2.30-2.31 m, RGM 569 180/1 fragment; 2.18-2.19 m, RGM 569 234/1 fragment; 2.16-2.17 m, RGM 569 253/1; 2.03-2.04 m, RGM 569 283/1 (Eemian).

Gravity core T87/2/20G, sample 0.05-0.06 m, RGM 569 406/1 (Fig. 56J) (Holocene).

Bologna samples: CR 20, RGM 570 403/3 fragments; J 74-9, RGM 570 600/3 fragments.



## Discussion

The identity of the 'beaked larva', as it was named by van der Spoel & Newman (1990), is still enigmatic. The curious, sinusigera-like apertural structures distinguish it from the gymnosome larvae described above, but other characteristics, as e.g. the ornament-free protoconch-1, the distinct constriction separating the younger shell-part with concentric and longitudinal ornament do resemble some of the gymnosomes, especially the one described as '*Erste Larvenart*' by Krohn (1860). The apertural structures, however, also visible in some of the present specimens (Fig. 56G, J) make me retain the provisional indication of 'beaked larva', even if van der Spoel & Newman observed a bilobed velum and 'interstitial tissue indicating that the specimens are juvenile'. In case that it will be concluded that these minute specimens indeed represent one of the unknown gymnosomatous larval shells it is evident that the slightly reinforced apertural margin with the 'hooks' indicates that what is called an 'early teleoconch' herein in fact is the final stage of protoconch-2 and the shell part indicated as such above for Genus *Clionidarum* sp. 1 and 2 is just a part of protoconch-2.

Menzies (1958) reported this curious species alive, as *Creseis chierchiae*, from a single station in the central Mediterranean, where it occurred in 13 specimens per 1000 cubic meters of filtered water. Referring to Menzies' erroneous identification, Corselli & Grecchi (1990: p. 96) do not accept the validity of the name *Creseis chierchiae* in the Mediterranean and referred to van der Spoel (1967), who considered this species to be the larval shell part of *Hyalocylis striata*. See also above, in the discussion of that species.

### Veliger larvae of benthic species? (Fig. 57A-F)

Veliger larva of unknown gastropod species? – Janssen, 2007a: p. 165, pl. 24, figs -7.

Veliger larva of benthic species? – Janssen, in press, fig. 69.

## Description

See Janssen (2007a). In a SEM close up (Fig. 57B) of the perforations present in the shells it can be seen that they penetrate the shell wall completely and that their shape is conical, basically resembling the perforations made by naticids, although of course considerably smaller.

## Material examined

Gravity core T87/2/20G, sample 2.73-2.74 m, RGM 569 086l/9; 2.67-2.68 m, RGM 569 087h/2; 2.59-2.60 m, RGM 569 091i/3; 2.54-2.55 m, RGM 569 092k/1; 2.47-2.48 m, RGM 569 095o/35; 2.45-2.46 m, RGM 569 100j/2; 2.42-2.43 m, RGM 569 119/29; 2.36-2.37 m, RGM 569 146a/6; 2.33-2.34 m, RGM 569 165h/3; 2.30-2.31 m, RGM 569 181i/1; 2.24-2.25 m, RGM 569 202g/4; 2.18-2.19 m, RGM 569 241/66, RGM 569 241a, b /2 (Fig. 57A-C); 2.16-2.17

m, RGM 569 252/40; 2.14-2.15 m, RGM 569 265/12; 2.14-2.15 m, RGM 569 270/76; 2.03-2.04 m, RGM 569 282/46; 1.97-1.98 m, RGM 569 291/18; 1.76-1.77 m, RGM 569 304g/2; 1.72-1.73 m, RGM 569 305m/7; 1.72-1.73 m, RGM 569 312/105, RGM 569 312a-c/3 (Fig. 57D-F); 1.68-1.69 m, RGM 569 323/190; 1.65-1.66 m, RGM 569 326f/4; 1.61-1.62 m, RGM 569 327g/2 (Eemian).

Gravity core T87/2/20G, sample 1.53-1.54 m, RGM 569 330h/4; 1.48-1.49 m, RGM 569 331i/4; 1.43-1.44 m, RGM 569 332k/1 (Weichselian).

Gravity core T87/2/20G, sample 0.18-0.19 m, RGM 569 369o/2; 0.17-0.18 m, RGM 569 373n/3; 0.12-0.13 m, RGM 569 383k/12; 0.11-0.12 m, RGM 569 389j/5; 0.095-0.105 m, RGM 569 391i/1; 0.05-0.06 m, RGM 569 407f/4 (Holocene).

Bologna samples: CJ 72 III-20, RGM 570 420/24; CJ 72 III-22, MZB (ex RGM 570 658)/5; CR 33, RGM 569 808/1; CR 42, RGM 570 376/1; CR 70, RGM 570 578/8; J 74-9, RGM 570 521/20; T74-55-6, RGM 570 928/3; T74-65-1, RGM 570 964/c. 50; T74-65-2, RGM 570 909/16.

## Discussion

The identity of these larval shells remains inscrutable. Janssen (in press) describes completely similar specimens from the Langhian (Miocene) of Malta and gives some reactions on the identity of these specimens, received from the world malacologists community through the internet as follows: 'Among the many reactions not one was able to identify these specimens. Most of the suggestions were Heterobranchia, with Pyramidellidae or Nudibranchia, as most probable groups. The possibility of Nudibranchia was ruled out by Dr Richard Willan (Museum and Art Gallery of the Northern Territory, Darwin, Australia). Dr Gary Rosenberg (Academy of Natural Sciences, Philadelphia, US) also suggested Pyramidellidae, with the perforations maybe made by blue-green algae. An explanation for the absence of a teleoconch might be that the animals don't start making that shell part until they encounter their host'. Professor Carole Hickman (University of California, Museum of Paleontology, Berkeley, CA, USA) also had a look at my SEM images and commented as follows: 'Your specimens are most intriguing. I have never seen anything like them before. The sinusigera aperture suggests two things: (1) It is a Caenogastropod, (2) It is a larval shell of something that has not yet metamorphosed. Is it possible that the pitted portion of the larval shell is covered by early post-metamorphic growth of a benthic juvenile? The pitting is interesting for at least four reasons: (1) It is not present initially, (2) There is no axial component to the pattern, and the spiral patterns are not highly organized, (3) The pits appear to penetrate the entire shell – at least in Fig. 57B –, and (4) In fig. 1a, the pitting was interrupted twice by breakage and shell repair. It is organized differently after the first breakage and never reappears after the second breakage. The pitting that I have observed in benthic microgastropods is shallow and very well organized – apparently under very strong biological control. What about



some form of infestation by another organism – attachment of hydroids?’.

Ahuva Almogi Labin (in litt., 2012) sampled this species alive and common in the Gulf of Aqaba, but did not observe the perforations in fresh specimens. Klaus Bandel (in litt. 2009) caught living specimens from the southern Red Sea and Gulf of Aden, and in his specimens the perforations were present indeed.

## Biostratigraphical notes based on gravity core T87/2/20G

Biostratigraphical conclusions are only possible from the species distribution in the gravity core, as from all other samples depth below sea bottom is unknown. A species range chart of the gravity core is presented in Tab. 3a, b. The chronology is based on planktonic Foraminifera analyses (van Rijckevorsel, 1988, section 3; Weltje, 1988, sections 1 and 2).

### Saalian (2.81-2.82 m)

Only the lowermost sample, just below sapropel S5, is dated as Saalian. It is relatively rich in species (19), but poor in specimens (124), among which only a single specimen of *Limacina retroversa*.

### Eemian (1.60 – 2.795 m)

In the basal sample of sapropel S5 the number of specimens increases to 1494, but they represent only 11 species, among which high numbers of *Atlanta* sp. (267), *Heliconoides inflata* (795), *Limacina lesueurii* (370) and, to a lesser degree, *Diacria trispinosa* (40). Both *Limacina retroversa* and *L. trochiformis* are absent in this sample. In the overlying six samples within S5 the number of specimens decreases upward and the number of species remains between 6 and 11 only.

The interval between S5 and S4 (2.21-2.48 m) is the richest part of the section, both in number of species (increasing to 27) and number of specimens (with a maximum of 2122 in sample 2.42-2.43 m). Among the represented species are ‘typical’ warmer water indicators, like *Heliconoides inflata* and *Limacina trochiformis*, as well as surprisingly many juveniles of *Cuvierina* sp. *Limacina retroversa* still is absent.

The two samples representing the S4 sapropel (2.16 – 2.19 m) yielded together 2186 specimens, belonging to 22 and 25 species. Especially juvenile *Atlanta* specimens, *Heliconoides inflata* and *Limacina trochiformis* are found in high numbers, still pointing to favorable conditions.

Between the S4 and S3 sapropels (1.72 – 2.15 m) the numbers of specimens (varying between 35 and 577 per sample) and species (between 7 and 19) decrease, but still with relative high numbers of the ‘warm’ species. *Cuvierina* sp. is only present with 5 protoconchs in the lowermost sample, its last occurrence in this core. A single specimen of *Limacina retroversa* is found in sample 2.09 – 2.10 m.

In the two lower samples of the three representing the S3 sapropel (1.65 – 1.71 m) the number of specimens increases again, but the composition of the assemblage remains similar (13 to 15 species per sample), with relatively high numbers of *Atlanta* sp. and *Heliconoides inflata*. Striking is a sudden increase of ‘veliger larvae’. The top sample of S3 (1.65 – 1.66 m) demonstrates a dramatic reduction, both in number of specimens (132) and number of species (8), which tendency is continued in the two Eemian samples overlying S3 (1.60 – 1.62 m), with only 4-7 species and 10-18 specimens.

### Weichselian (0.26 – 1.59 m)

In this interval the number of species and specimens per sample is strongly reduced. The ‘warm’ water indicator *Heliconoides inflata* is present in very low numbers in the basal part (0.87 – 1.59 m, with a maximum of only 18 specimens in sample 1.43 – 1.44 m). It reappears in the topmost two Weichselian samples. In the same interval in which *H. inflata* practically disappears, the ‘cold’ water indicator *Limacina retroversa* appears in most samples between 0.30 and 0.94 m, but with very low numbers (0-8) per sample only. The species *Clio pyramidata*, relatively common during the Eemian interval, occurs in very few specimens in the lower Weichselian parts, but increases a bit towards the top again.

### Holocene (0.05 – 0.23 m)

The three basal samples, below sapropel S1, show similar species distributions as the top Weichselian sample (number of species 11-13, number of specimens 114-272). *Heliconoides inflata* is back in much higher numbers, *Limacina bulimoides* increases markedly in numbers and *Diacria trispinosa* also is present again, all of these facts pointing to higher water temperatures.

That trend is continued during deposition of S1 and in the three samples overlying S1. The number of species per sample is between 10 and 18, with a maximum of 22 in the topmost sample. Also juvenile *Cavolinia* sp. is present again, after almost complete disappearance during the Weichselian, and the same is true for *Protatlanta souleyeti*. *Firoloida desmarestia*, hardly noted in the lower parts of the section, is present in all samples between 0.05 and 0.18 m.

A comparison with van Straaten’s (1966) core 309, taken in the SE Adriatic Sea, demonstrates substantial differences. That core, reaching a depth of more than 5 m below seabottom, was subdivided on the basis of molluscan assemblages into six ‘stages’, the lowermost of which, covering a thickness of 144 cm, is characterized by a strong predominance of *Limacina retroversa*. In his conclusions van Straaten interpreted this assemblage as ‘the coldest period of the late Pleistocene’. This agrees more or less with the occurrence of *L. retroversa* in core T87/20/20G, interval 30-94 cm below sea bottom, the later part of the Weichselian. The higher ‘stages’ of van Straaten are not clearly recognizable in this core, as ap-



parently sedimentation rate in the Adriatic has been considerably higher. Although almost continuously present in the said interval *L. retroversa* by no means reaches the number of specimens as recorded for the Adriatic. The few specimens found during the Holocene interval (at 18–21 cm below sea floor) could easily be explained by activities of burrowing organisms. The fact, however, that *L. retroversa* is commonly present in several of the other bottom samples analyzed for this study indicates that the Holocene cover of the sea bottom locally is rather thin and that late Pleistocene sediments are frequently touched by simple dredging.

## Conclusions

In the present study holoplanktonic molluscs of 62 bottom samples (box core, beam trawl and 'dredge' samples) from the eastern Mediterranean were analyzed. Of a single gravity core, split in 71 samples of cm-size, the sieving fractions < 0.6 mm were also evaluated. The total number of species found in all samples together is 48 (Pterotracheoidea 11, Janthinidae 2, Limacinoidea 5, Cavolinioidea 16, Cymbulioidea 8, Gymnosomata 4, *incertae sedis* 2), 31 of these were also demonstrated in the gravity core samples.

As the stratigraphical provenance of all bottom samples (depth below sea bottom) is unknown, results obtained from their residues only give information on which species have been present in the roughly estimated interval 'late Pleistocene to Holocene, Recent included'. As the numerous samples of the gravity core were previously dated on the basis of planktonic Foraminifera, comprising the interval of latest Saalian to Holocene, more detailed information on the vertical distribution of the species could be obtained. Results acknowledge in general the usual interpretation of the pteropod *Limacina retroversa*, occurring in assemblages poor in species, being an indicator species for cooler periods, and species like *Atlanta* spp., *Heliconoides inflata*, *Limacina trochiformis* accompanied by a much larger number of additional species, marking periods of higher water temperatures. Construction of a 'palaeoclimatological curve', as done by numerous earlier authors, was not attempted.

In the systematic part a neotype is designated for *Atlanta keraudrenii* Lesueur, 1817, and a lectotype for *Steira lamanoni* Eschscholtz, 1825, making both taxa to junior synonyms of *Atlanta peronii* Lesueur, 1817. *Clio pyramidata* f. *tyrrhenica* nov. f. is introduced. For many species morphological details are discussed and many questions concerning systematics and/or nomenclature are discussed, in many cases also related to the desired position of a taxon at species, subspecies, or infraspecific level. In most of these questions the present author maintains a conservative point of view, anticipating and looking forward to future molecular work.

## Acknowledgements

Samples of gravity core T87/2/20G were donated in 1992 to the RGM collections by Jan Willem Biekart, at the time of the Geological Institute of Utrecht University (The Netherlands). Also I thank Gert-Jan Weltje of the same institute for additional data and literature concerning that core. Further basic material underlying the present paper was made available by the Senckenberg Museum (Frankfurt am Main, Germany) and I thank Ronald Janssen and Siegrid Hof for their much appreciated cooperation. Ionian and Tyrrhenian Sea samples were obtained from the Istituto Geologia Marina (ISMAR-CNR) at Bologna (Italy), through the kind support of Marco Taviani. Lorenzo Angeletti, of the same institute, assisted with sample preparation and shipments. Cruise CORSARO was conducted in the frame of the EU Hermes programme; thanks are due to Mastre, Crew and Scientific Staff onboard RV *Urania*. Constantine Mifsud (Rabat, Malta), David P. Cilia (Santa Venera, Malta), Alberto Villari (Messina, Sicily, Italy) and Geert-Jan Brummer (Free University of Amsterdam, The Netherlands) made specimens or samples available. Julian Evans (Malta) allowed reproduction of his photograph of living *Creseis clava*. Discussions on predominantly systematical topics were very helpful with Ahuva Almogi-Labin (Geological Survey of Israel, Jerusalem, Israel), Klaus Bandel (Geologisches Institut der Universität, Hamburg, Germany), Ruud Bank (Hoogezand, The Netherlands), Carole Hickman (University of California, Museum of Paleontology, Berkeley, CA, USA), Robert Moolenbeek (Zoölogisch Museum, Amsterdam, The Netherlands), Jeannine Rampal (Université Aix-Marseille, France), Gary Rosenberg (Academy of Natural Sciences, Philadelphia, USA), Roger R. Seapy (California State University, Fullerton, USA), Anders Warén (Naturhistoriska Riksmuseet, Stockholm, Sweden) and Richard Willan (Museum and Art Gallery of the Northern Territory, Darwin, Australia). I also want to thank the numerous friends and colleagues who reacted on my repeated requests in malacological list servers on the internet, concerning the 'veliger larvae'.

Of the colleagues in NCB Naturalis (Leiden, The Netherlands) I'd like to memorize the help of Jeroen Goud (for making samples available), Frank Wesselingh and Ronald Pouwer (for discussions and making photographs), Cees van den Berg and Jack van Oyen (for technical assistance related to SEM-imaging), and Agnes Bavelaar-Dekker and Edit Lajtos (for their great help in finding necessary literature).

Much appreciated critical reading by Ahuva Almogi-Labin (Geological Survey of Israel, Jerusalem, Israel), Irene Zorn (Geologische Bundesanstalt, Vienna, Austria) and Rafael LaPerna, editor of the present periodical, improved the manuscript considerably.













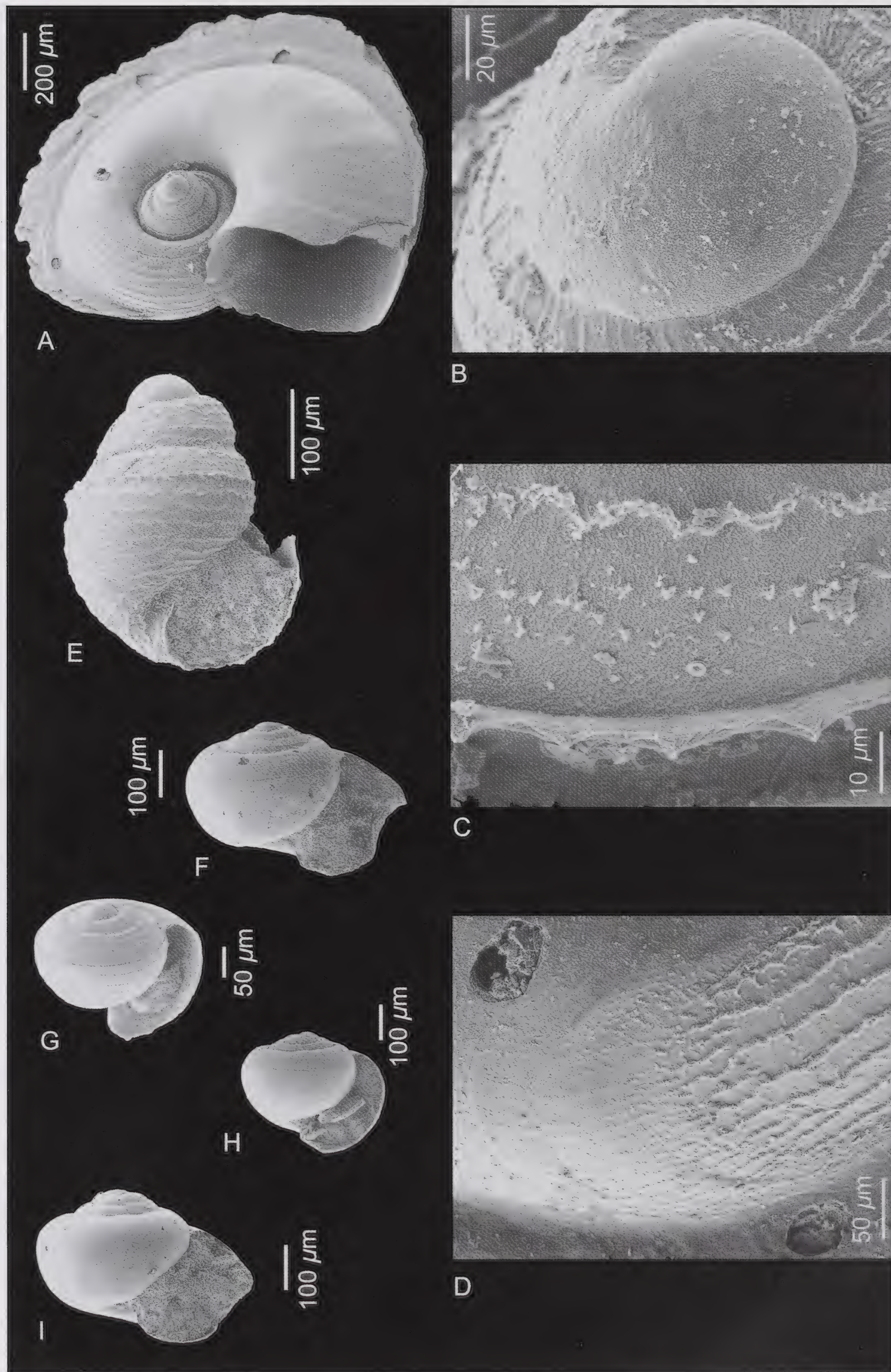


Localities  Species		Ionian Sea															Tyrrhenian Sea										
		Corsaro 2006							Bannock 1972						Bannock 1973-1974						Bannock 1974						
		CR 20	CR 31	CR 33	CR 34	CR 39	CR 42	CR 68	CR 70	CJ72 III-20	CJ72 III-21	CJ72 III-22	CJ72 III-23	CJ72 III-25	CJ72 III-27	J73-6	J73-17	J73-29	J74-9	J74-10	J74-12	J74-19	T74-55-6	T74-65-1	T74-65-2	T74-65-9	T74-65-10
<i>Atlanta brunnea</i>	5	.	3	1	16	8	38	8	1	10	4	.	2	.	.	.	.	.	31	.	4	.	.	m	40	.	.
<i>Atlanta helicinoidea</i>	.	.	.	.	11	1	4	.	.	5	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.
<i>Atlanta lesueurii</i>	5	5	.	m	m	5	m	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	
<i>Atlanta peronii</i>	26	7	7	9	m	64	m	33	.	m	.	1	40	1	.	.	.	.	m	4	39	.	22	m	m	2	20
<i>Atlanta selvagensis</i>	m	11	5	m	m	m	m	m	.	m	24	.	m	19	.	.	.	.	m	30	62	.	m	m	m	.	.
<i>Atlanta</i> sp.	.	.	18	.	.	.	.	m	m	.	.	.	.	.	.	.	.	.	m	.	.	.	.	.	.	.	
<i>Oxygyrus inflatus</i>	2	2	4	1	25	16	30	4	.	11	.	.	3	1	.	.	.	.	25	1	5	.	1	40	13	.	.
<i>Protatlanta souleyeti</i>	25	8	20	m	m	m	m	16	.	m	.	.	30	27	.	.	.	.	m	4	16	.	16	.	35	.	.
<i>Firoloida desmarestia</i>	28	1	23	m	m	m	m	m	m	m	m	.	m	26	.	.	.	.	m	.	12	1	.	m	m	.	.
<i>Pterotrachea</i> sp. 1	.	.	7	6	24	30	12	10	.	1	1	.	.	4	.	.	.	.	m	10	4	.	.	7	9	.	.
<i>Pterotrachea</i> sp. 2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	
<i>Carinaria lamarckii</i>	40	11	17	11	m	40	m	m	16	m	14	.	42	m	.	.	1	m	2	35	.	23	m	50	2	1	
<i>Janthina</i> sp.	.	.	.	1	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	2	2	.	.
<i>Heliconoides inflata</i>	m	m	m	m	m	m	m	m	m	m	m	.	m	m	.	1	20	m	m	m	.	m	m	m	.	2	
<i>Limacina bulimoides</i>	m	21	30	.	m	8	m	m	.	.	.	.	29	m	.	.	3	10	7	11	.	40	m	5	.	.	
<i>Limacina retroversa</i>	m	m	m	2	21	m	m	30	.	.	4	.	m	m	m	m	m	.	1	6	30	m	m	.	m	50	
<i>Limacina trochiformis</i>	18	9	.	19	m	45	m	20	20	m	23	.	25	3	.	.	.	.	m	4	22	.	.	40	50	.	.
<i>Creseis clava</i>	m	8	25	m	m	42	m	m	30	36	28	.	13	30	.	.	1	m	4	35	.	.	m	m	.	1	
<i>Creseis conica</i>	m	50	50	m	m	m	m	m	45	m	m	.	25	19	.	.	1	m	15	50	.	2	m	m	.	.	
<i>Hyalocylis striata</i>	4	5	1	3	20	11	13	2	.	.	.	.	1	.	.	.	.	43	.	3	.	.	.	1	.	.	
<i>Hyalocylis striata</i> f. <i>obtusa</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	
<i>Styliola subula</i>	m	m	m	m	m	m	m	m	m	m	m	.	m	24	.	.	3	m	.	m	.	.	m	m	11	m	
<i>Clio cuspidata</i>	30	11	17	11	m	m	m	15	9	21	19	1	7	1	.	.	1	m	.	17	.	.	35	19	.	4	
<i>Clio oblonga</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	2	.	5	
<i>Clio pyramidata</i> f. <i>lanceolata</i>	m	m	m	m	m	m	m	m	m	m	m	m	m	m	10	15	m	m	30	m	.	.	m	m	6	m	
<i>Clio pyramidata</i> f. <i>tyrrhenica</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	m	.	.	m	.	7	.	14	
<i>Clio polita</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	
<i>Cavolinia gibbosa</i> f. <i>gibboides</i>	.	.	.	.	1	1	.	.	.	14	.	3	2	.	.	.	.	12	.	1	.	.	.	.	.	.	
<i>Cavolinia inflexa</i> f. <i>imitans</i>	3	3	.	.	3	8	3	.	.	m	.	15	2	.	.	1	5	m	.	6	.	.	7	1	3	m	
<i>Cavolinia tridentata</i>	.	1	.	.	.	.	.	.	.	10	.	.	.	.	.	2	2	1	.	2	.	.	1	1	1	10	
<i>Cavolinia</i> sp. (protoconchs)	m	23	16	30	m	45	m	21	5	8	14	.	m	7	.	.	17	m	9	50	.	.	m	18	.	.	
<i>Diacria trispinosa</i>	9	.	11	.	3	1	5	27	5	1	1	1	2	m	.	.	4	2	.	1	.	m	3	2	1	.	
<i>Cymbulia</i> sp. 1	.	.	2	4	6	14	1	1	.	.	.	.	.	1	.	.	.	m	5	.	.	.	.	.	.	.	
<i>Cymbulia</i> sp. 2	.	.	5	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	
<i>Gleba cordata</i>	7	.	11	10	m	m	m	m	35	40	7	.	12	m	.	.	1	m	8	8	.	.	m	m	.	.	
<i>Peracle diversa</i>	1	2	.	.	23	5	21	.	.	2	1	.	7	.	.	.	.	16	.	1	.	.	5	1	.	.	
<i>Peracle elata</i>	.	.	2	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
<i>Peracle moluccensis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
<i>Peracle reticulata</i>	5	5	11	6	m	35	m	5	.	15	2	.	8	2	.	.	.	m	1	9	.	2	16	8	.	.	
<i>Peracle?</i> sp.	5	.	7	14	20	30	15	20	.	3	.	.	17	.	.	.	.	m	16	14	.	18	31	11	.	.	
Genus Clionidarum sp. 1	.	.	3	.	.	20	2	6	28	22	2	.	6	m	.	.	.	m	13	8	.	18	m	23	.	.	
Genus Clionidarum sp. 2	.	.	2	.	1	.	.	9	15	3	1	.	7	5	.	.	1	m	.	2	.	2	35	11	.	.	
Genus Clionidarum sp. 4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	
Genus Clionidarum sp. 5	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	15	.	.	.	.	.	.	.	.	
beaked larvae	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	
veliger larvae of benthic species?	.	.	1	.	.	1	.	8	24	.	5	.	.	.	.	.	.	20	.	.	.	3	50	16	.	.	
number of species per sample	26	22	30	24	31	31	31	29	17	27	21	6	27	23	2	6	14	38	21	30	2	17	27	33	9	12	

Tab. 5. Bologna samples. Numbers of specimens per sample, total number of species per sample (m = > 100).

Tab. 5. Campioni di Bologna. Numero di esemplari per campione, numero totale di specie per campione (m = > 100).

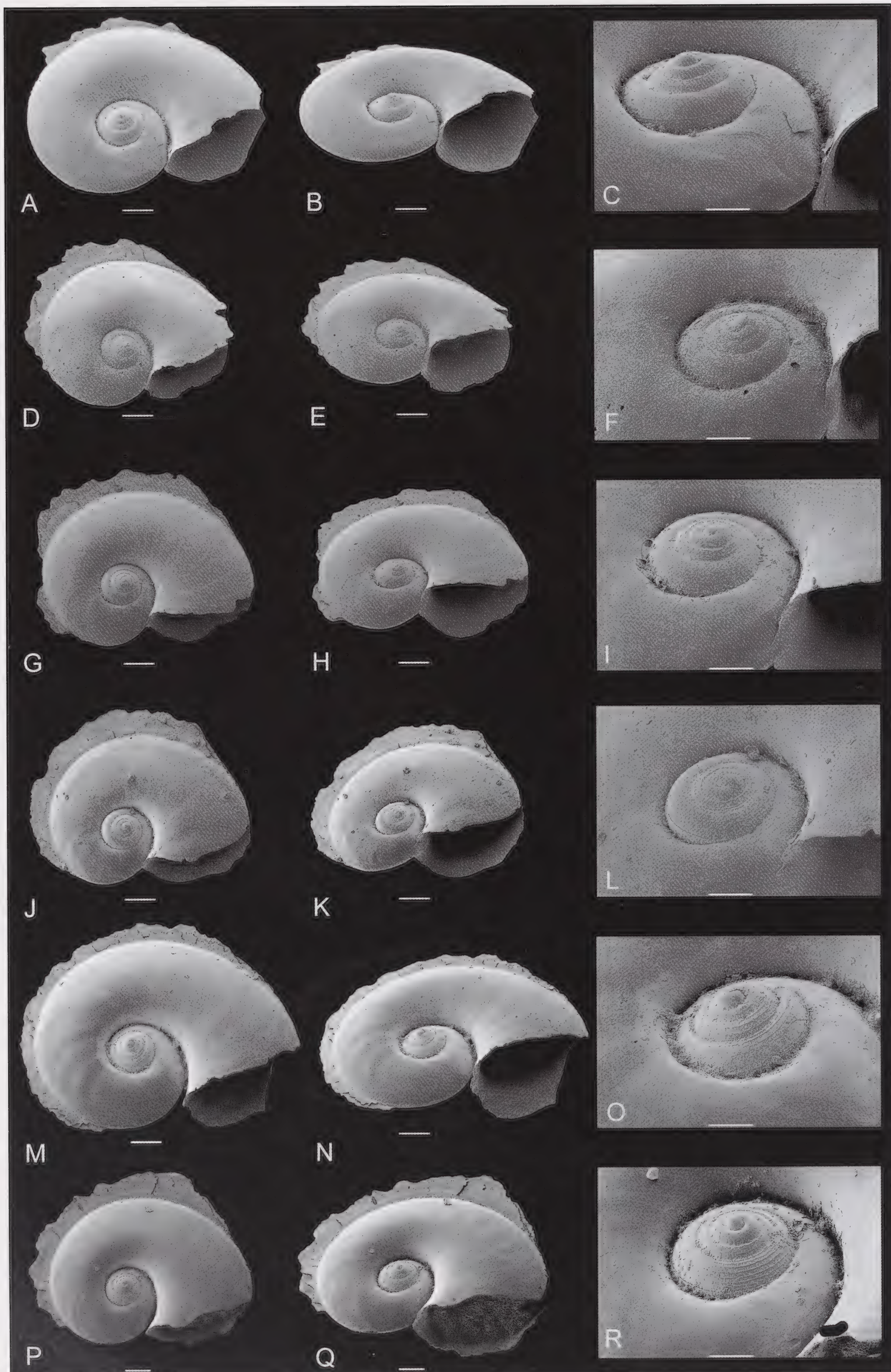




**Fig. 40. A-E.** *Atlanta brunnea* J.E. Gray, 1850. **A-D.** Meteor 25, sta 37, Kg 1, RGM 541 608a. **A.** Oblique apical view. **B.** Nucleus of protoconch magnified. **C.** Detail of middle protoconch whorl. **D.** Boundary between proto- and teleoconch. **E.** Core T87/2/20G, 2.36-2.37 m, RGM 569 120a; protoconch, apertural view. **F-H.** *Atlanta* sp. Core T87/2/20G, sample 2.36-2.37 m, RGM 569 121a-c; protoconchs, apertural views. **I.** Core T87/2/20G, sample 2.24-2.25 m, RGM 569 183; protoconch, apertural view. F-I most probably all belong to *A. selvagensis*.

**Fig. 40. A-E.** *Atlanta brunnea* J.E. Gray, 1850. **A-D.** Meteor 25, stazione 37, Kg 1, RGM 541 608a. **A.** Vista apicale obliqua. **B.** Dettaglio di nucleo e protoconca. **C.** Dettaglio di una porzione intermedia della protoconca. **D.** Limite protoconca-teleoconca. **E.** Carota T87/2/20G, 2.36-2.37 m, RGM 569 120a; protoconca, vista aperturale. **F-H.** *Atlanta* sp. Carota T87/2/20G, campione 2.36-2.37 m, RGM 569 121a-c; protoconche, viste aperturali. **I.** Carota T87/2/20G, campione 2.24-2.25 m, RGM 569 183; protoconca, vista aperturale. Gli esemplari delle figure F-I molto probabilmente appartengono tutte ad *A. selvagensis*.

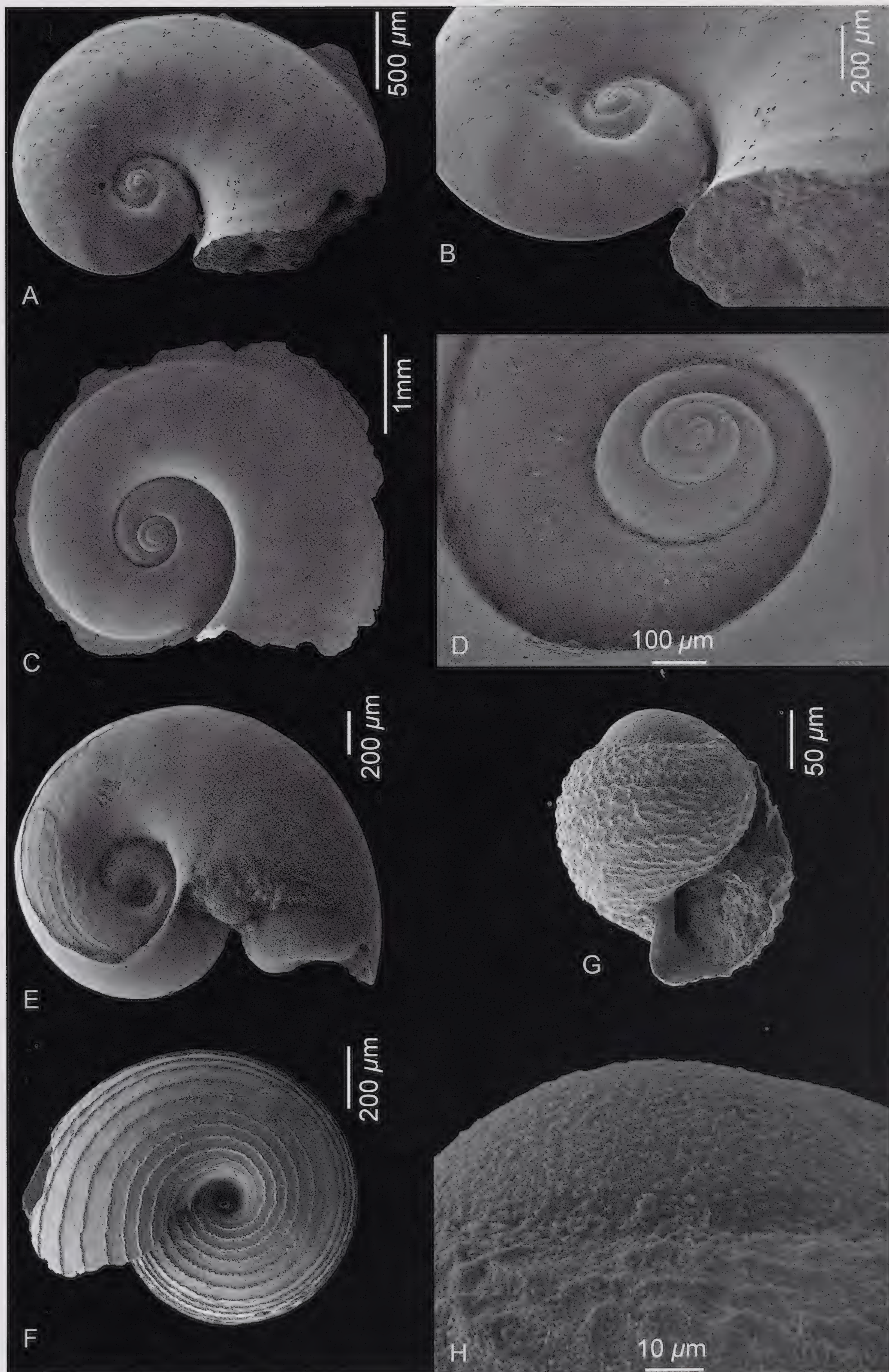




**Fig. 41. A-R.** *Atlanta selvagensis* de Vera & Seapy, 2006. Meteor 25, sta 37 Kg 1; RGM 541 611e-j; **A-F.** No spiral elements. **G-L.** Weak spirals. **M-R.** Strong spirals. Left: apical views, middle: oblique apical views, right: protoconchs magnified.

**Fig. 41. A-R.** *Atlanta selvagensis* de Vera & Seapy, 2006. Meteor 25, stazione 37 Kg 1; RGM 541 611e-j; **A-F.** Senza elementi spirali. **G-L.** Con deboli elementi spirali. **M-R.** Con forti elementi spirali. Sinistra: viste apicali, centro: vedute apicali oblique, destra: dettaglio della protoconca.

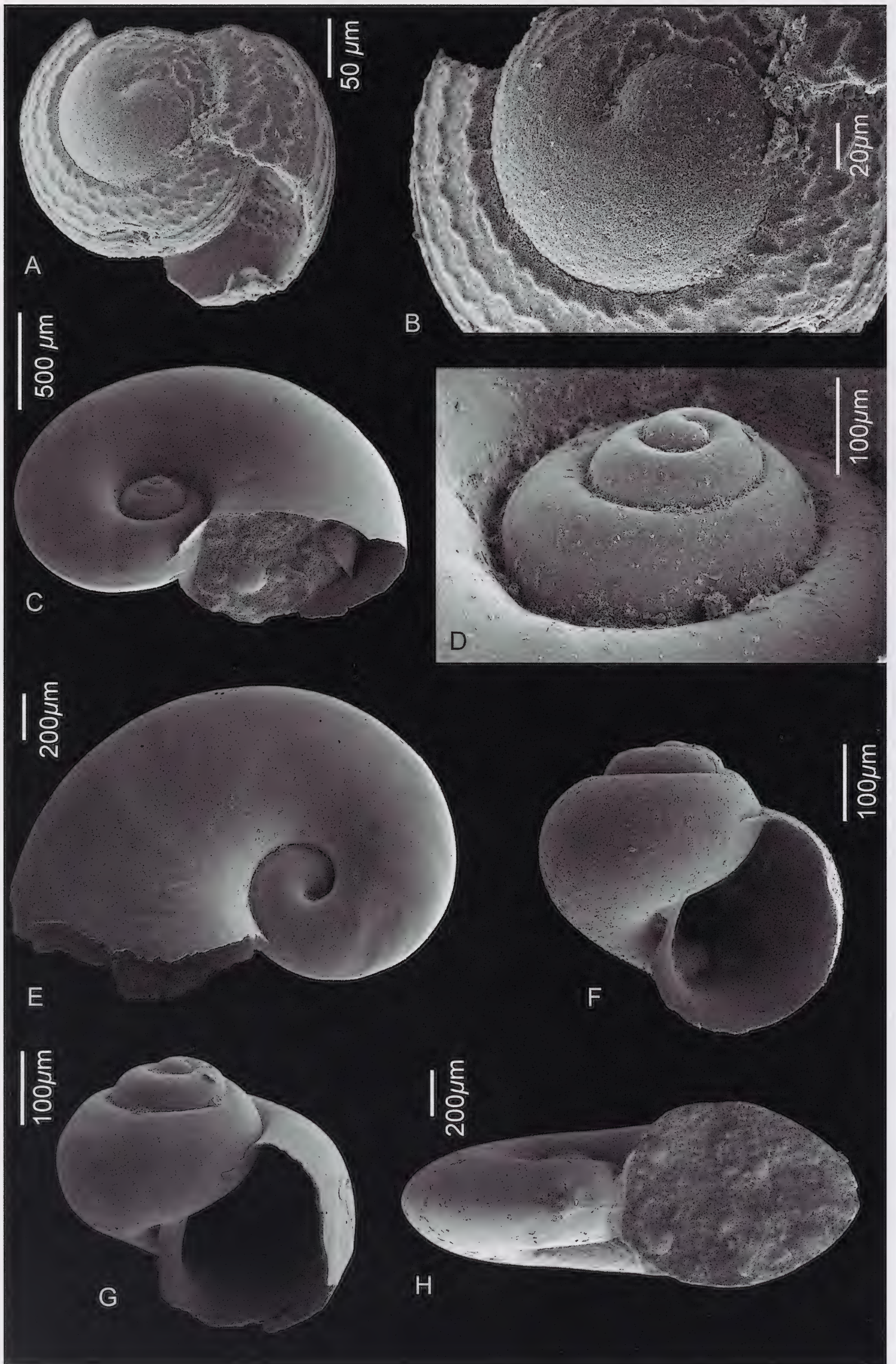




**Fig. 42.** **A, B.** *Atlanta lesueurii* J.E. Gray, 1850. Meteor 25 sta 37 Kg 1; RGM 541 609a; **A.** Apical view, **B.** Oblique apical view, magnified. **C, D.** *Atlanta peronii* Lesueur, 1817. Meteor 25 sta 37 Kg 1; RGM 541 610a. **C.** Apical view, **D.** Protoconch magnified. **E-H.** *Oxygyrus inflatus* Benson, 1835. **E, F.** Meteor 25 sta 37 Kg 1; RGM 541.612a-b. **E.** Apical view. **F.** Juvenile specimen, umbilical view. **G, H.** Core T87/2/20G, sample 2.33-2.34 m; RGM 569 148a. **G.** Very juvenile specimen showing nucleus, apertural view. **H.** Nucleus of protoconch, magnified.

**Fig. 42.** **A, B.** *Atlanta lesueurii* J.E. Gray, 1850. Meteor 25 stazione 37 Kg 1; RGM 541 609a; **A.** Vista apicale, **B.** Dettaglio apicale. **C, D.** *Atlanta peronii* Lesueur, 1817. Meteor 25 stazione 37 Kg 1; RGM 541 610a. **C.** Vista apicale. **D.** Dettaglio apicale. **E-H.** *Oxygyrus inflatus* Benson, 1835. **E, F.** Meteor 25 stazione 37 Kg 1; RGM 541.612a-b. **E.** Vista apicale. **F.** Esemplare juvenile, vista umbilicale. **G, H.** Carota T87/2/20G, campione 2.33-2.34 m; RGM 569 148a. **G.** Esemplare molto immatura mostrante il nucleo, vista aperturale. **H.** Dettaglio del nucleo.

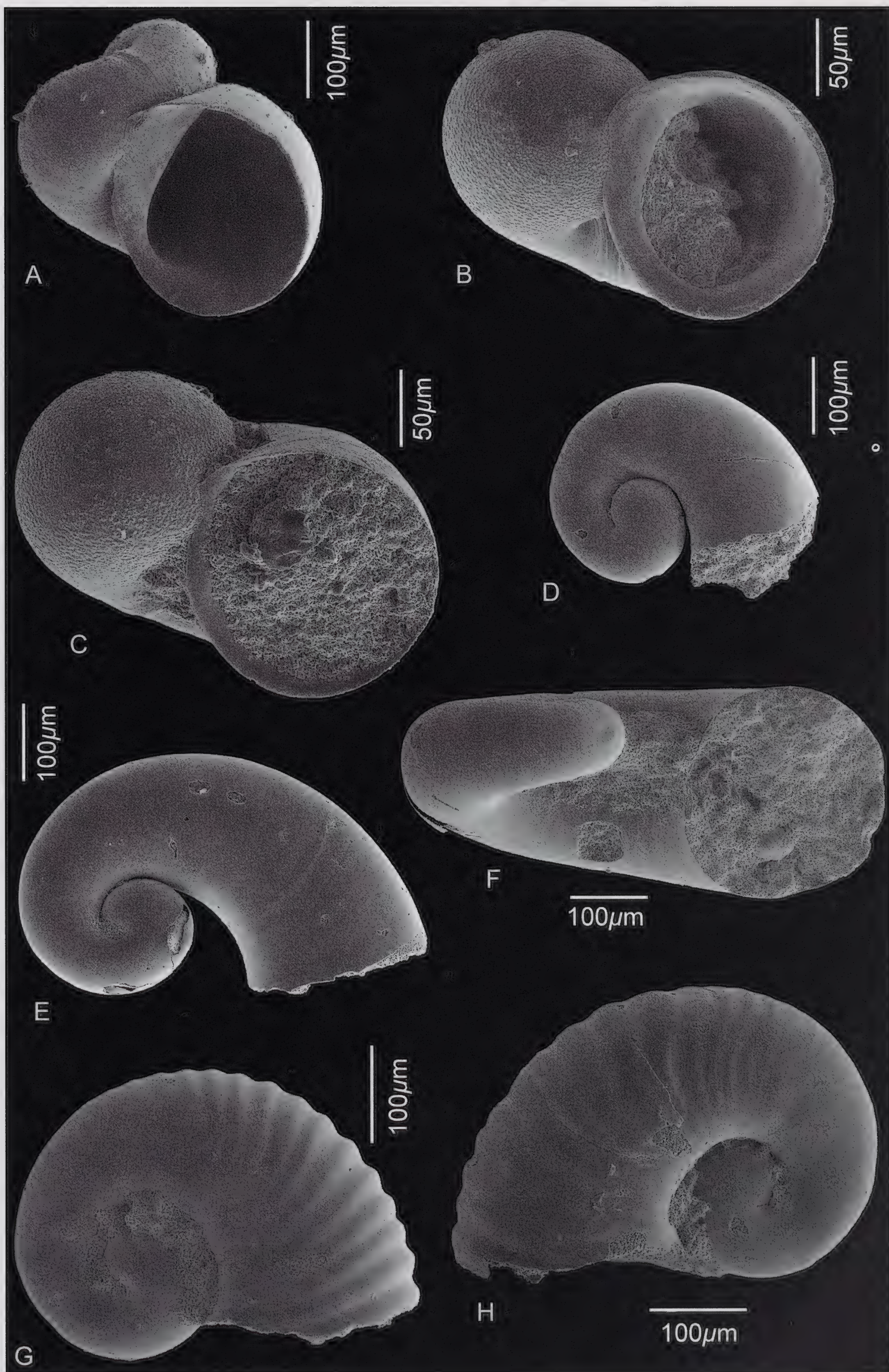




**Fig. 43. A, B.** *Oxygyrus inflatus* Benson, 1835. Core T87/2/20G, sample 2.03-2.04 m, RGM 569 272a. **A.** Apical view. **B.** Apical view, magnified. **C-H.** *Protatlanta souleyeti* (Smith, 1888). Meteor 25, sta 37, Kg 1, RGM 541 613a-c. **C.** Oblique apical view. **D.** The same, magnified. **E.** Umbilical view. **F.** Core T87/2/20G, sample 2.21-2.22 m, RGM 569 205a; juvenile, apertural view. **G.** Core T87/2/20G, sample 0.25-0.26 m, RGM 569 357a; juvenile, apertural view. **H.** Meteor 25, sta 37, Kg 1, RGM 541 613a-c; adult, apertural view.

**Fig. 43. A, B.** *Oxygyrus inflatus* Benson, 1835. Carota T87/2/20G, campione 2.03-2.04 m, RGM 569 272a. **A.** Vista apicale. **B.** Dettaglio apicale. **C-H.** *Protatlanta souleyeti* (Smith, 1888). Meteor 25, stazione 37, Kg 1, RGM 541 613a-c. **C.** Vista apicale obliqua. **D.** Dettaglio apicale. **E.** Vista umbilicale. **F.** Carota T87/2/20G, campione 2.21-2.22 m, RGM 569 205a; esemplare juvenile, vista aperturale. **G.** Carota T87/2/20G, campione 0.25-0.26 m, RGM 569 357a; esemplare juvenile, vista aperturale. **H.** Meteor 25, stazione 37, Kg 1, RGM 541 613a-c; esemplare adulto, vista aperturale.

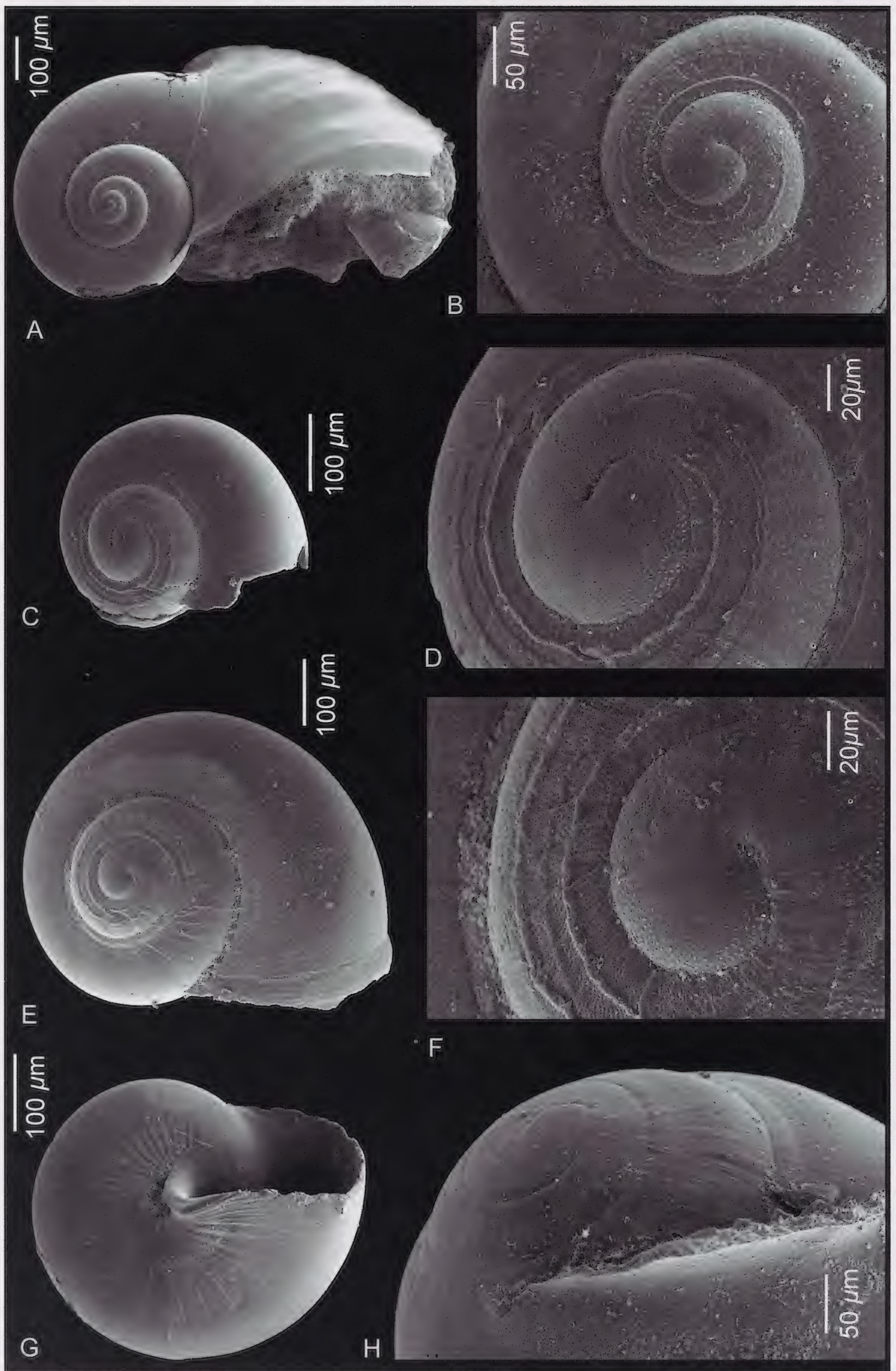




**Fig. 44. A-C.** *Fioloida desmarestia* Lesueur, 1817. **A, B.** Core T87/2/20G, sample 0.095-0.105 m, RGM 569.390a-b. **A.** Semiadult, apertural view. **B.** Juvenile, apertural view. **C.** Core T87/2/20G, sample 0.05-0.06 m, RGM 569.394a; juvenile, apertural view. **D-F.** *Pterotrachea* sp. 1. **D.** Core T87/2/20G, sample 2.24-2.25 m, RGM 569.186a; juvenile, apical view. **E, F.** Core T87/2/20G, sample 2.42-2.43 m, RGM 569.104a-b; fully grown larval shells. **E.** Apical view. **F.** Apertural view. **G, H.** *Pterotrachea* sp. 2, fully grown larval shells. **G.** Core T87/2/20G, sample 2.18-2.19 m, RGM 569.228; apical view. **H.** Core T87/2/20G, sample 2.42-2.43 m, RGM 569.105a; umbilical view.

**Fig. 44. A-C.** *Fioloida desmarestia* Lesueur, 1817. **A, B.** Carota T87/2/20G, campione 0.095-0.105 m, RGM 569.390a-b. **A.** Esemplare sub-adulto, vista aperturale. **B.** Esemplare juvenile, vista aperturale. **C.** Carota T87/2/20G, campione 0.05-0.06 m, RGM 569.394a; esemplare juvenile, vista aperturale. **D-F.** *Pterotrachea* sp. 1. **D.** Carota T87/2/20G, campione 2.24-2.25 m, RGM 569.186a; esemplare juvenile, vista apicale. **E, F.** Carota T87/2/20G, campione 2.42-2.43 m, RGM 569.104a-b; conchiglia larvale a piena crescita. **E.** Vista apicale. **F.** Viste aperturali. **G, H.** *Pterotrachea* sp. 2; conchiglia larvale a piena crescita. **G.** Carota T87/2/20G, campione 2.18-2.19 m, RGM 569.228; vista apicale. **H.** Carota T87/2/20G, campione 2.42-2.43 m, RGM 569.105a; vista umbilicale.

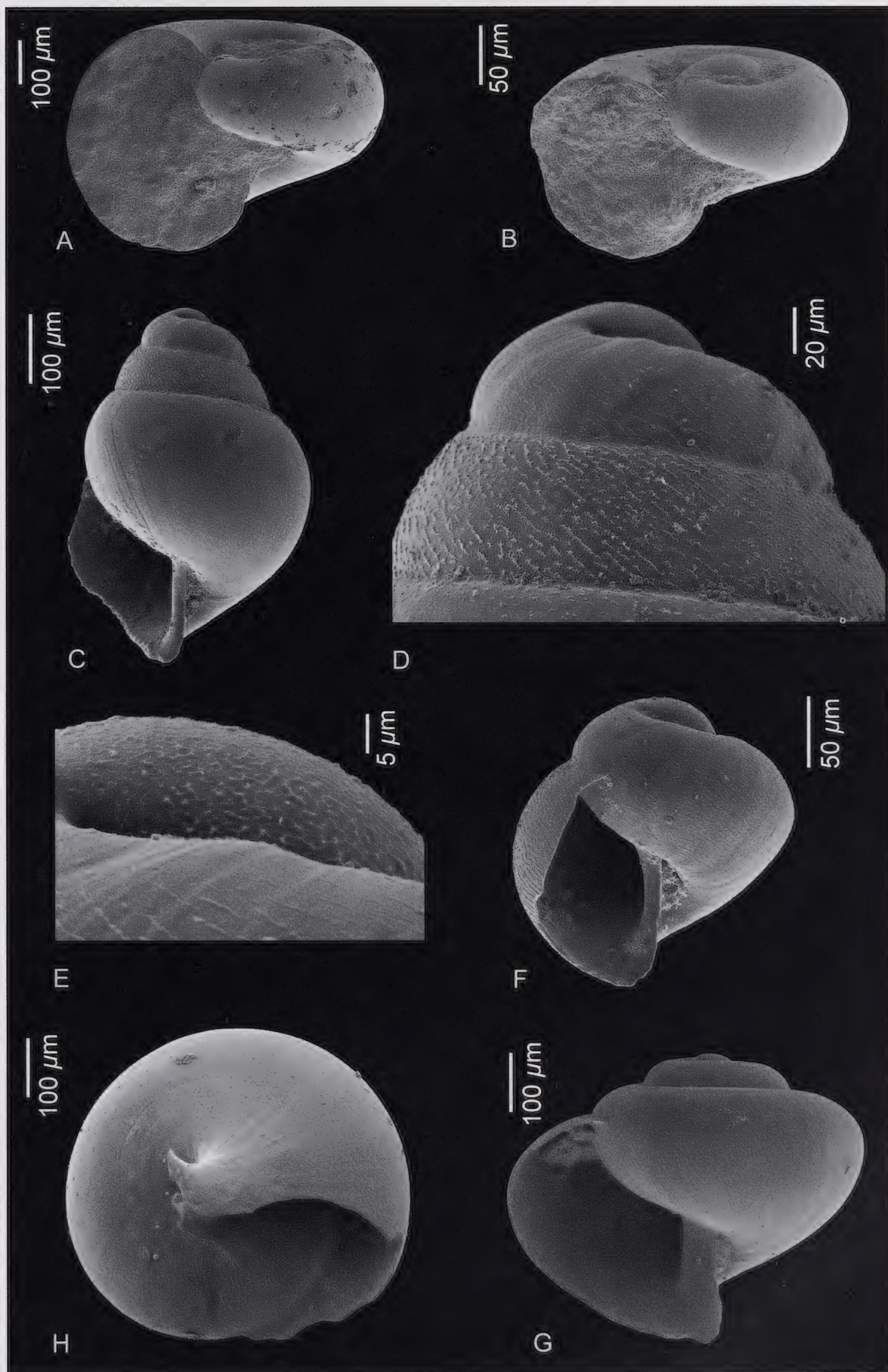




**Fig. 45. A-G.** *Carinaria lamarckii* de Blainville, 1817. **A, B.** Meteor 25, sta 37, Kg 1, RGM 541.614a; juvenile specimen. **A.** Apical view. **B.** Protoconch magnified. **C, D.** Core T87/2/20G, sample 2.36-2.37 m, RGM 569.126a; protoconch. **C.** Apical view. **D.** Nucleus and first whorl magnified. **E-G.** Core T87/2/20G, sample 1.68-1.69 m, RGM 569.314b-c; protoconchs. **E.** Apical view. **F.** Nucleus and first whorl magnified. **G.** Umbilical view. **H.** *Janthina janthina* (Linné, 1758)?, Meteor 25, sta 37, Kg 1, RGM 541.616; protoconch.

**Fig. 45. A-G.** *Carinaria lamarckii* de Blainville, 1817. **A, B.** Meteor 25, stazione 37, Kg 1, RGM 541.614a; esemplare juvenile. **A.** Vista apicale. **B.** Dettaglio della protoconca. **C, D.** Carota T87/2/20G, campione 2.36-2.37 m, RGM 569.126a; protoconca. **C.** Vista apicale. **D.** Dettaglio del nucleo e del primo giro. **E-G.** Carota T87/2/20G, campione 1.68-1.69 m, RGM 569.314b-c; protoconca. **E.** Vista apicale. **F.** Dettaglio del nucleo e del primo giro. **G.** Vista umbilicale. **H.** *Janthina janthina* (Linné, 1758)?, Meteor 25, stazione 37, Kg 1, RGM 541.616; protoconca.

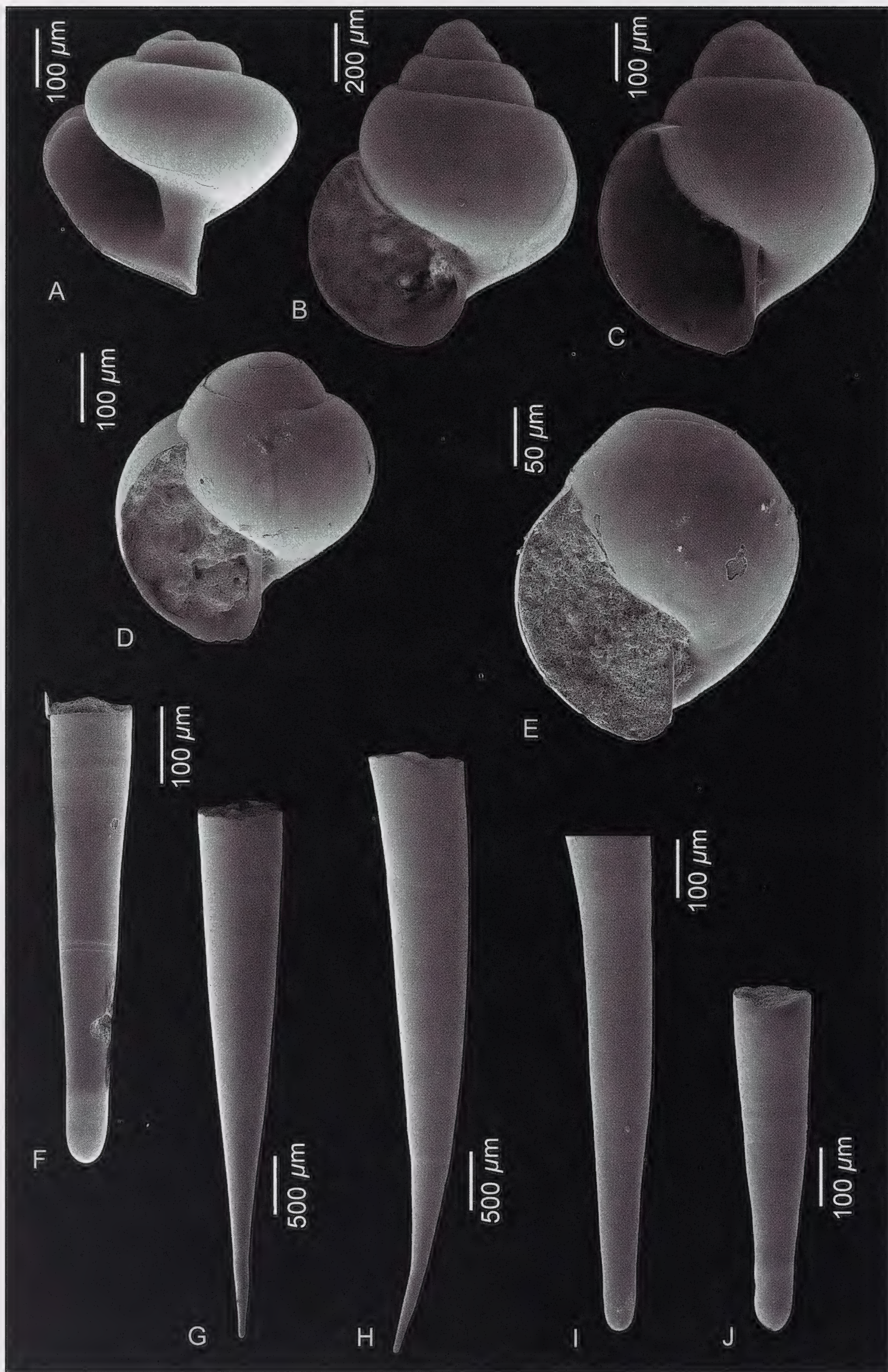




**Fig. 46.** **A, B.** *Heliconoides inflata* (d'Orbigny, 1834). Core T87/2/20G, sample 2.24-2.25 m, RGM 569.189b-c; apertural views. **C-F.** *Limacina bulimoides* (d'Orbigny, 1834). **C-E.** Core T87/2/20G, sample 0.13-0.13 m, RGM 569.378a-b. **C.** Apertural view. **D.** Apical whorls magnified. **E.** Nucleus magnified. **F.** Juvenile specimen, apertural view. **G, H.** *Limacina lesueurii* (d'Orbigny, 183). Core T87/2/20G, sample 2.785-2.795 m, RGM 569.081b. **G.** Apertural view. **H.** Umbilical views.

**Fig. 46.** **A, B.** *Heliconoides inflata* (d'Orbigny, 1834). Carota T87/2/20G, campione 2.24-2.25 m, RGM 569.189b-c; vista aperturale. **C-F.** *Limacina bulimoides* (d'Orbigny, 1834). **C-E.** Carota T87/2/20G, campione 0.13-0.13 m, RGM 569.378a-b. **C.** Vista aperturale. **D.** Dettaglio dei giri apicali. **E.** Nucleo. **F.** Esemplare juvenile, vista aperturale. **G, H.** *Limacina lesueurii* (d'Orbigny, 183). Carota T87/2/20G, campione 2.785-2.795 m, RGM 569.081b. **G.** Vista aperturale. **H.** Vista umbilicale.

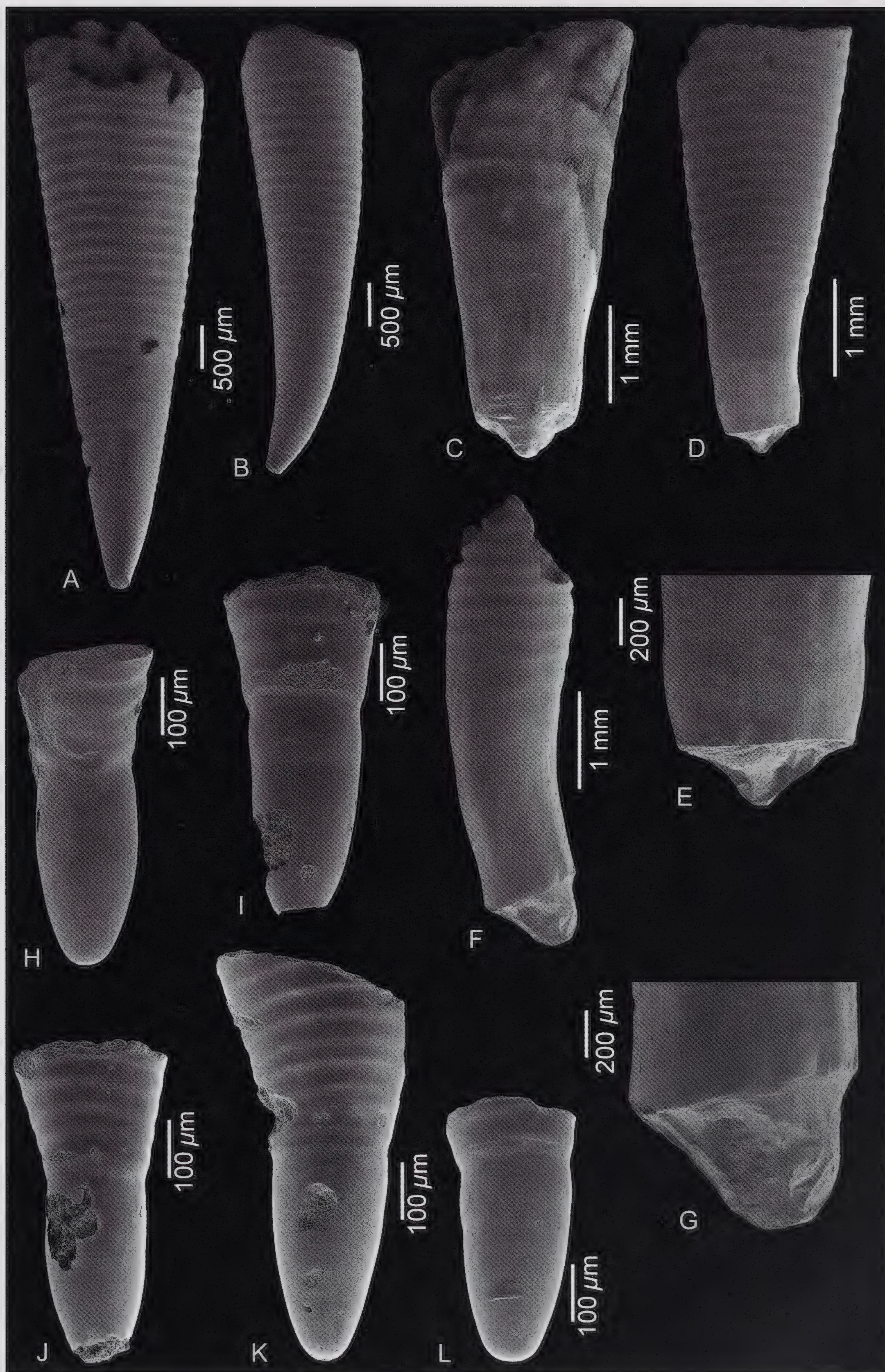




**Fig. 47.** **A.** *Limacina retroversa* (Fleming, 1823). Core T87/2/20G, sample 0.93-0.94 m, RGM 569 339a, juvenile; apertural view. **B-E.** *Limacina trochiformis* (d'Orbigny, 1834). **B, C.** Meteor 25, sta 37, Kg 1, RGM 541.618a-b, juveniles, apertural views. **D, E.** Core T87/2/20G, sample 2.36-2.37 m, RGM 569 128a-b, juveniles; apertural views. **F-J.** *Creseis conica* Eschscholtz, 1829. **F.** Core T87/2/20G, sample 2.36-2.37 m, RGM 569 129a, protoconch. **G-I.** Meteor 25, sta 37, Kg 1, 3 June 1993, RGM 541 620a-b; **G.** Frontal view. **H.** Lateral view. **I.** Protoconch magnified. **J.** Core T87/2/20G, sample 2.36-2.37 m RGM 569 130a; protoconch.

**Fig. 47.** **A.** *Limacina retroversa* (Fleming, 1823). Carota T87/2/20G, campione 0.93-0.94 m, RGM 569 339a, esemplare juvenile; vista aperturale. **B-E.** *Limacina trochiformis* (d'Orbigny, 1834). **B, C.** Meteor 25, stazione 37, Kg 1, RGM 541.618a-b, esemplari juvenili, viste aperturali. **D, E.** Carota T87/2/20G, campione 2.36-2.37 m, RGM 569 128a-b, esemplari juvenili; viste aperturali. **F-J.** *Creseis conica* Eschscholtz, 1829. **F.** Carota T87/2/20G, campione 2.36-2.37 m, RGM 569 129a, protoconca. **G-I.** Meteor 25, stazione 37, Kg 1, 3 June 1993, RGM 541 620a-b; **G.** Vista frontale. **H.** Vista laterale. **I.** Dettaglio della protoconca. **J.** Carota T87/2/20G, campione 2.36-2.37 m RGM 569 130a; protoconca.

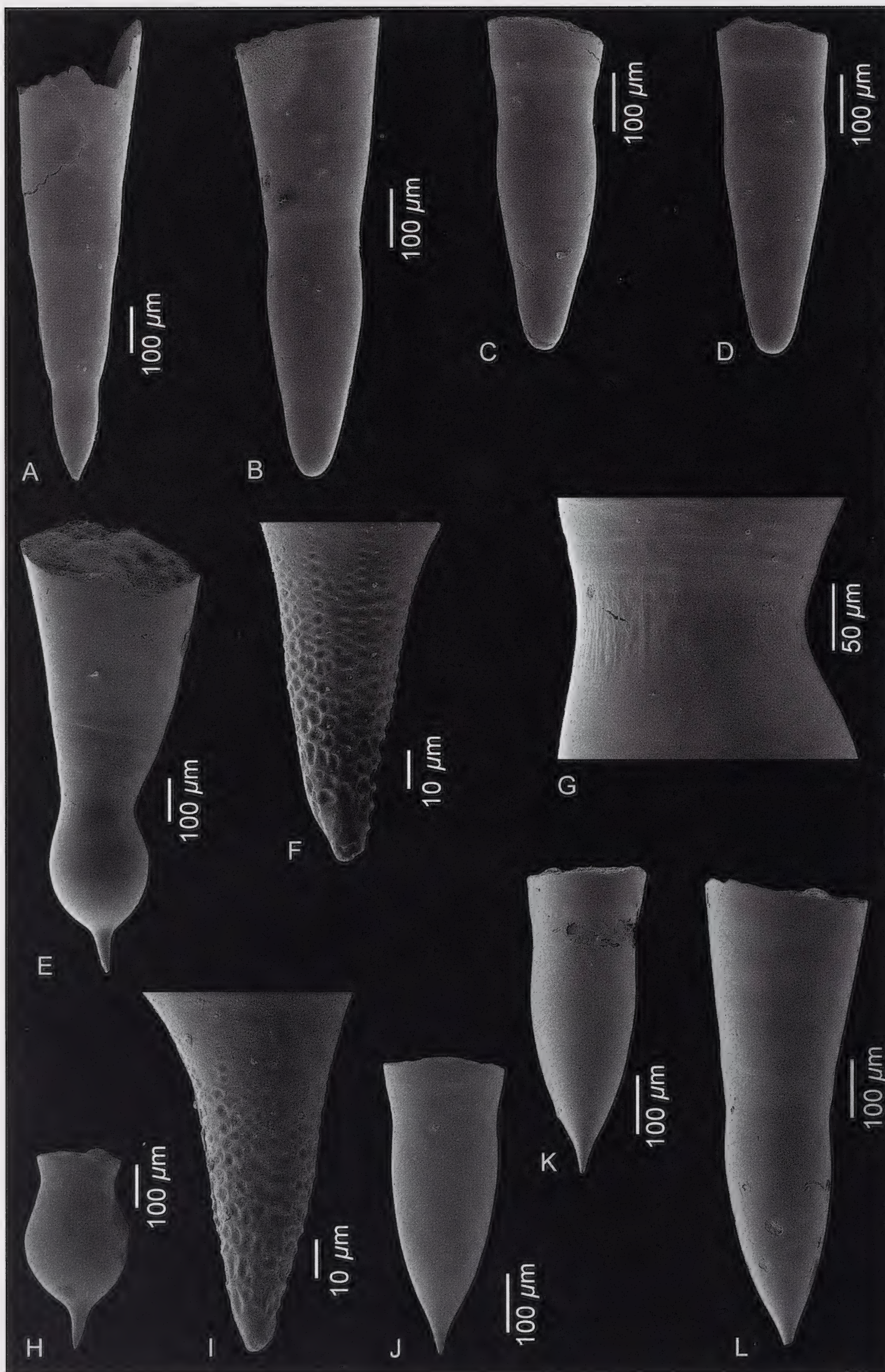




**Fig. 48. A-L.** *Hyalocylis striata* (Rang, 1828). **A, B.** Meteor 25, sta 37, Kg 1, RGM 541.621a-b. **A.** Ventral view. **B.** Left lateral view. **C-G.** Forma *obtusa* Di Geronimo, 1974. Meteor 25, sta 37, Kg 1, 3 June 1993, RGM 541.622a-c. **C.** Apical shell part. **D.** Right lateral view. **E.** Apical shell part magnified. **F.** Right lateral view. **G.** Apical shell part magnified. **H.** Protoconch, core T87/2/20G, sample 2.21-2.22 m, RGM 569.212a. **I.** Protoconch, core T87/2/20G, sample 2.30-2.31 m, RGM 569.171a. **J.** Protoconch, core T87/2/20G, sample 2.24-2.25 m, RGM 569.191a. **K.** Protoconch, core T87/2/20G, sample 2.36-2.37 m RGM 569.131a. **L.** Protoconch, core T87/2/20G, sample 2.42-2.43 m, RGM 569.109a.

**Fig. 48. A-L.** *Hyalocylis striata* (Rang, 1828). **A, B.** Meteor 25, stazione 37, Kg 1, RGM 541.621a-b. **A.** Vista ventrale. **B.** Vista laterale sinistra. **C-G.** Forma *obtusa* Di Geronimo, 1974. Meteor 25, stazione 37, Kg 1; 3 Giugno 1993, RGM 541.622a-c. **C.** Porzione apicale. **D.** Vista laterale destra. **E.** Dettaglio della porzione apicale. **F.** Vista laterale destra. **G.** Dettaglio della porzione apicale. **H.** Protoconca, carota T87/2/20G, campione 2.21-2.22 m, RGM 569.212a. **I.** Protoconca, carota T87/2/20G, campione 2.30-2.31 m, RGM 569.171a. **J.** Protoconca, carota T87/2/20G, campione 2.24-2.25 m, RGM 569.191a. **K.** Protoconca, carota T87/2/20G, campione 2.36-2.37 m RGM 569.131a. **L.** Protoconca, carota T87/2/20G, campione 2.42-2.43 m, RGM 569.109a.

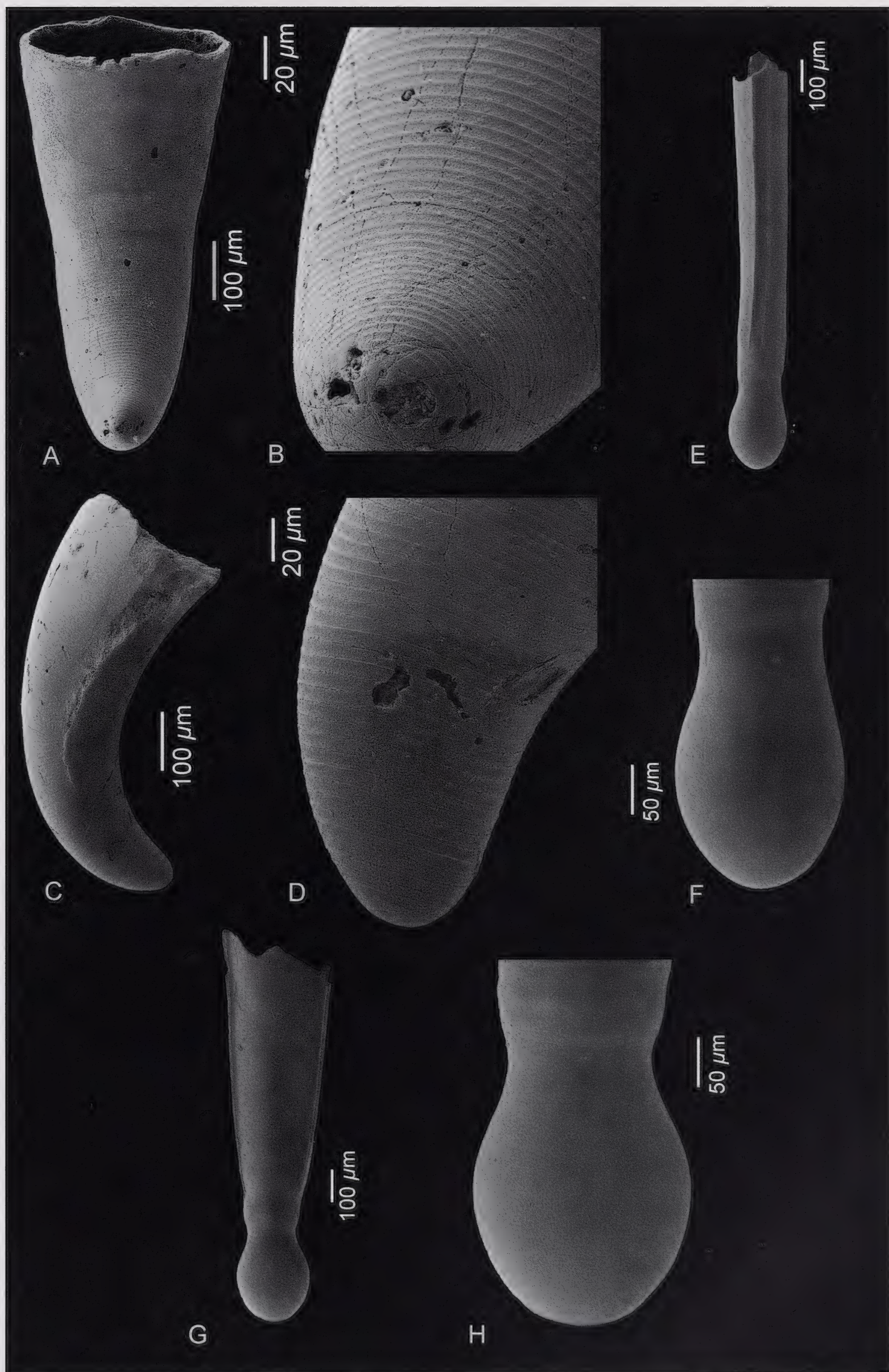




**Fig. 49.** **A.** *Styliola subula* (Quoy & Gaimard, 1827). Core T87/2/20G, sample 2.18-2.19 m, RGM 569.230a, protoconch. **B-D.** *Cuvierina* (s. lat.) sp. Protoconchs, core T87/2/20G, sample 2.36-2.37 m, RGM 569.132a-c. **E-I.** *Clio* (*Bellardiclio*) *cuspidata* (Bosc, 1802). **E-G.** Core T87/2/20G, sample 2.33-2.34 m, RGM 569.155a. **E.** Protoconch and early teleoconch. **F.** Apical spine magnified. **G.** Microornament at the transition of protoconch and teleoconch. **H, I.** Core T87/2/20G, sample 2.21-2.22 m, RGM 569.215a. **H.** Protoconch. **I.** Apical spine magnified. **J-L.** *Clio* (*Clio*) *pyramidata* Linné, 1767, protoconchs. **J, K.** Core T87/2/20G, sample 2.36-2.37 m, RGM 569.134b-c. **L.** Core T87/2/20G, sample 2.36-2.37 m, RGM 569.134a.

**Fig. 49.** **A.** *Styliola subula* (Quoy & Gaimard, 1827). Carota T87/2/20G, campione 2.18-2.19 m, RGM 569.230a, protoconca. **B-D.** *Cuvierina* (s. lat.) sp. Protoconche, carota T87/2/20G, campione 2.36-2.37 m, RGM 569.132a-c. **E-I.** *Clio* (*Bellardiclio*) *cuspidata* (Bosc, 1802). **E-G.** Carota T87/2/20G, campione 2.33-2.34 m, RGM 569.155a. **E.** Protoconca e teleoconca iniziale. **F.** Dettaglio della spina apicale. **G.** Microscultura alla transizione protoconca-teleoconca. **H, I.** Carota T87/2/20G, campione 2.21-2.22 m, RGM 569.215a. **H.** Protoconca. **I.** Dettaglio della spina apicale. **J-L.** *Clio* (*Clio*) *pyramidata* Linné, 1767, protoconche. **J, K.** Carota T87/2/20G, campione 2.36-2.37 m, RGM 569.134b-c. **L.** Carota T87/2/20G, campione 2.36-2.37 m, RGM 569.134a.

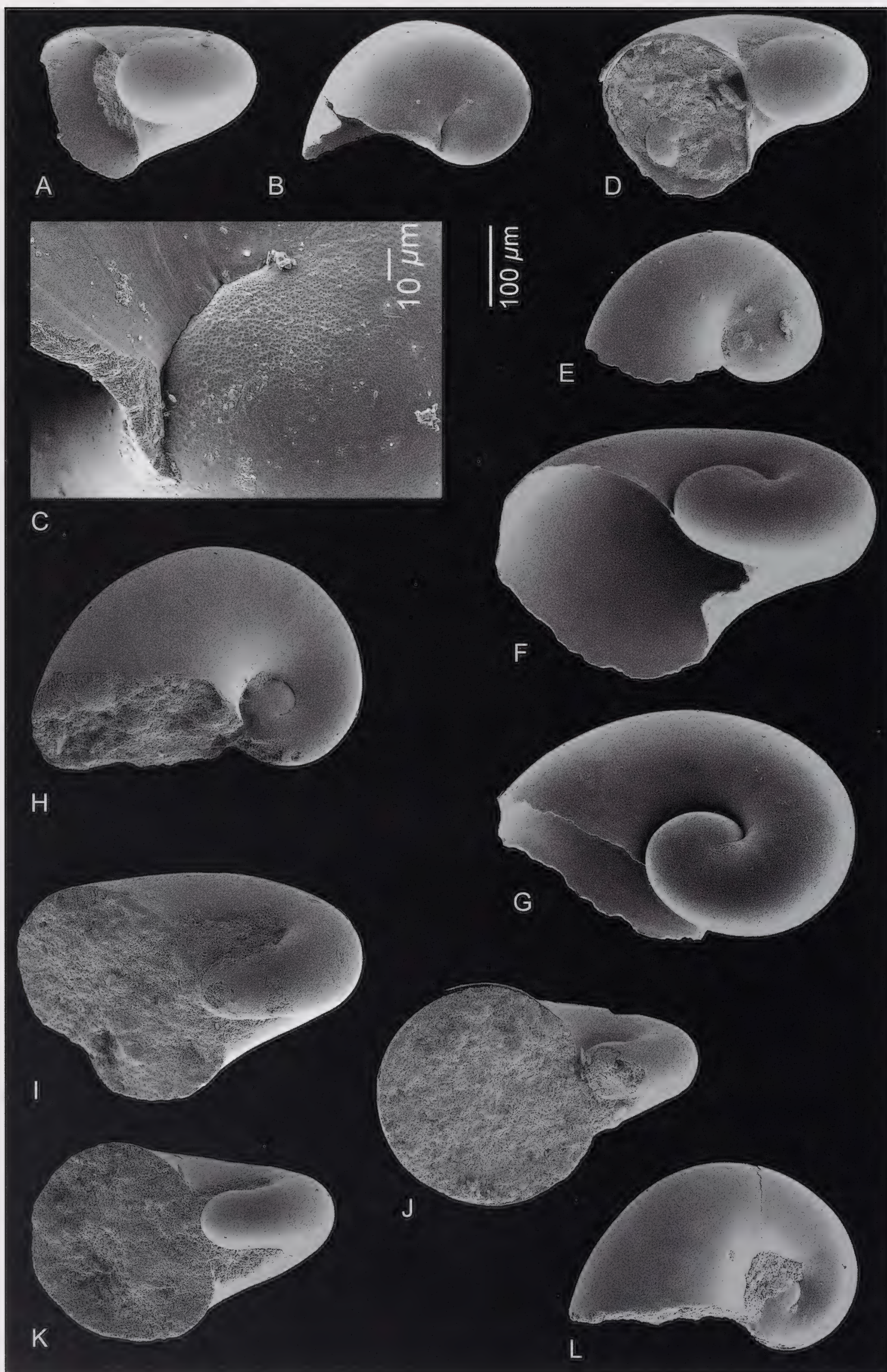




**Fig. 50. A-D.** *Cavolinia* sp. Core T87/2/20G, sample 2.36-2.37 m, RGM 569135a-b. **A.** Protoconch, dorsal view. **B.** Tip of protoconch magnified. **C.** Protoconch, left lateral view. **D.** Tip of protoconch magnified. **E-H.** *Diacria trispinosa* (Blainville, 1821). Core T87/2/20G, sample 2.785-2.795 m RGM 569 082a-b. **E.** Protoconch, lateral view. **F.** Protoconch magnified. **G.** Protoconch, frontal view. **H.** Protoconch magnified.

**Fig. 50. A-D.** *Cavolinia* sp. Carota T87/2/20G, campione 2.36-2.37 m, RGM 569135a-b. **A.** Protoconca, vista dorsale. **B.** Dettaglio dell'apice della protoconca. **C.** Protoconca, vista laterale sinistra. **D.** Dettaglio dell'apice della protoconca. **E-H.** *Diacria trispinosa* (Blainville, 1821). Carota T87/2/20G, campione 2.785-2.795 m RGM 569 082a-b. **E.** Protoconca, vista laterale. **F.** Dettaglio della protoconca. **G.** Protoconca, vista frontale. **H.** Dettaglio della protoconca.

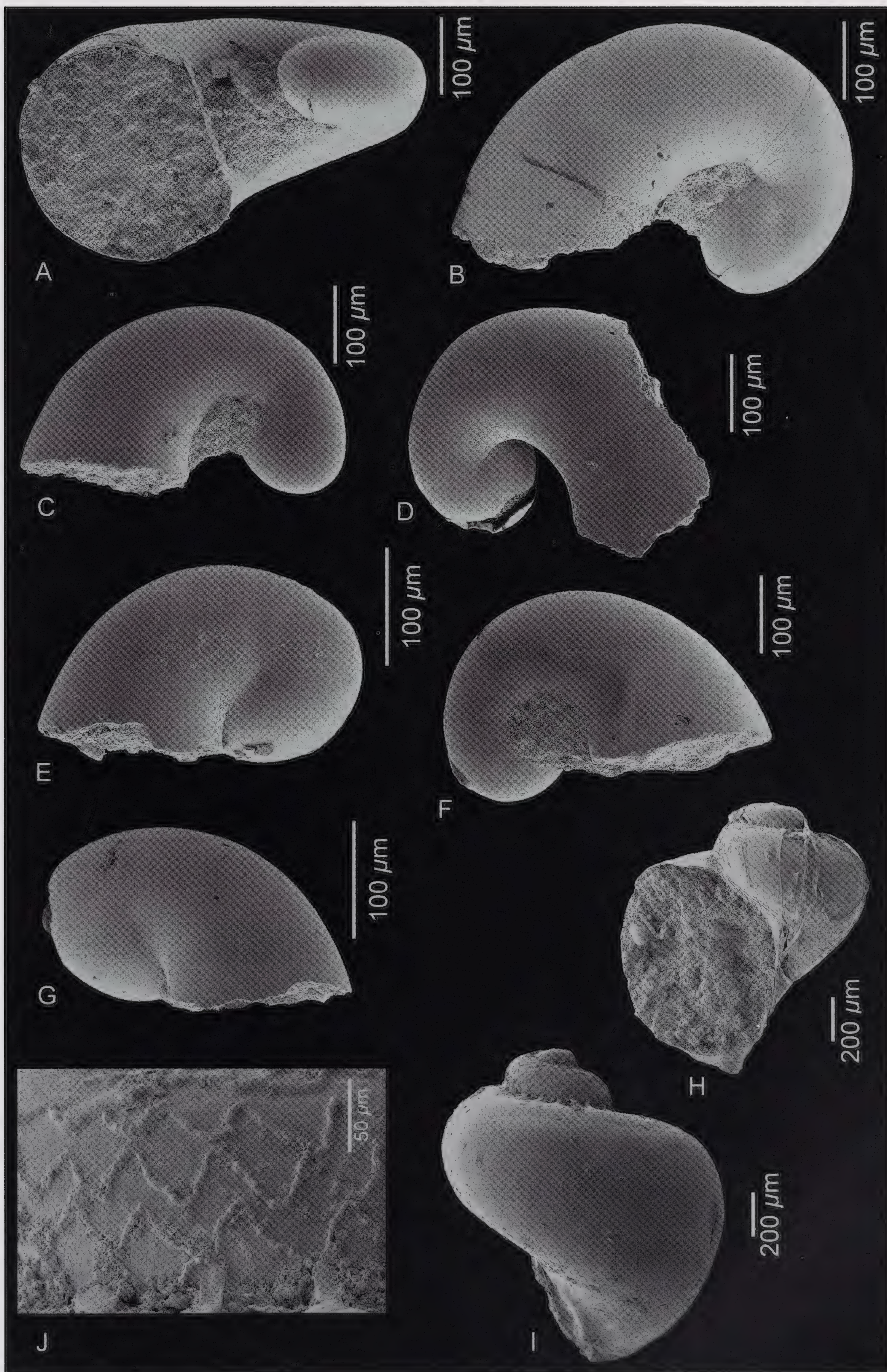




**Fig. 51. A-G.** *Cymbulia* sp. 1. **A-E.** Core T87/2/20G, sample 1.68-1.69 m. RGM 569.318a-d. **A.** Apertural view. **B.** Apical view. **C.** Nucleus magnified. **D.** Apertural view. **E.** Apical view. **F, G.** Core T87/2/20G, sample 2.81-2.82 RGM 569.074. **F.** Apertural view. **G.** Apical view. **H-L.** *Cymbulia* sp. 2. **H.** Core T87/2/20G, sample 2.36-2.37 m, RGM 569.140a; apical view. **I-K.** Core T87/2/20G, sample 2.24-2.25 m, RGM 569.197a-c; apertural views. **L.** Data as for 51H, RGM 569 140b; apical view.

**Fig. 51. A-G.** *Cymbulia* sp. 1. **A-E.** Carota T87/2/20G, campione 1.68-1.69 m. RGM 569.318a-d. **A.** Vista aperturale. **B.** Vista apicale. **C.** Dettaglio del nucleo. **D.** Vista aperturale. **E.** Vista apicale. **F, G.** Carota T87/2/20G, campione 2.81-2.82 RGM 569.074. **F.** Vista aperturale. **G.** Vista apicale. **H-L.** *Cymbulia* sp. 2. **H.** Carota T87/2/20G, campione 2.36-2.37 m, RGM 569.140a; vista apicale. **I-K.** Carota T87/2/20G, campione 2.24-2.25 m, RGM 569.197a-c; viste aperturali. **L.** Stessi dati di 51H, RGM 569 140b; vista apicale.

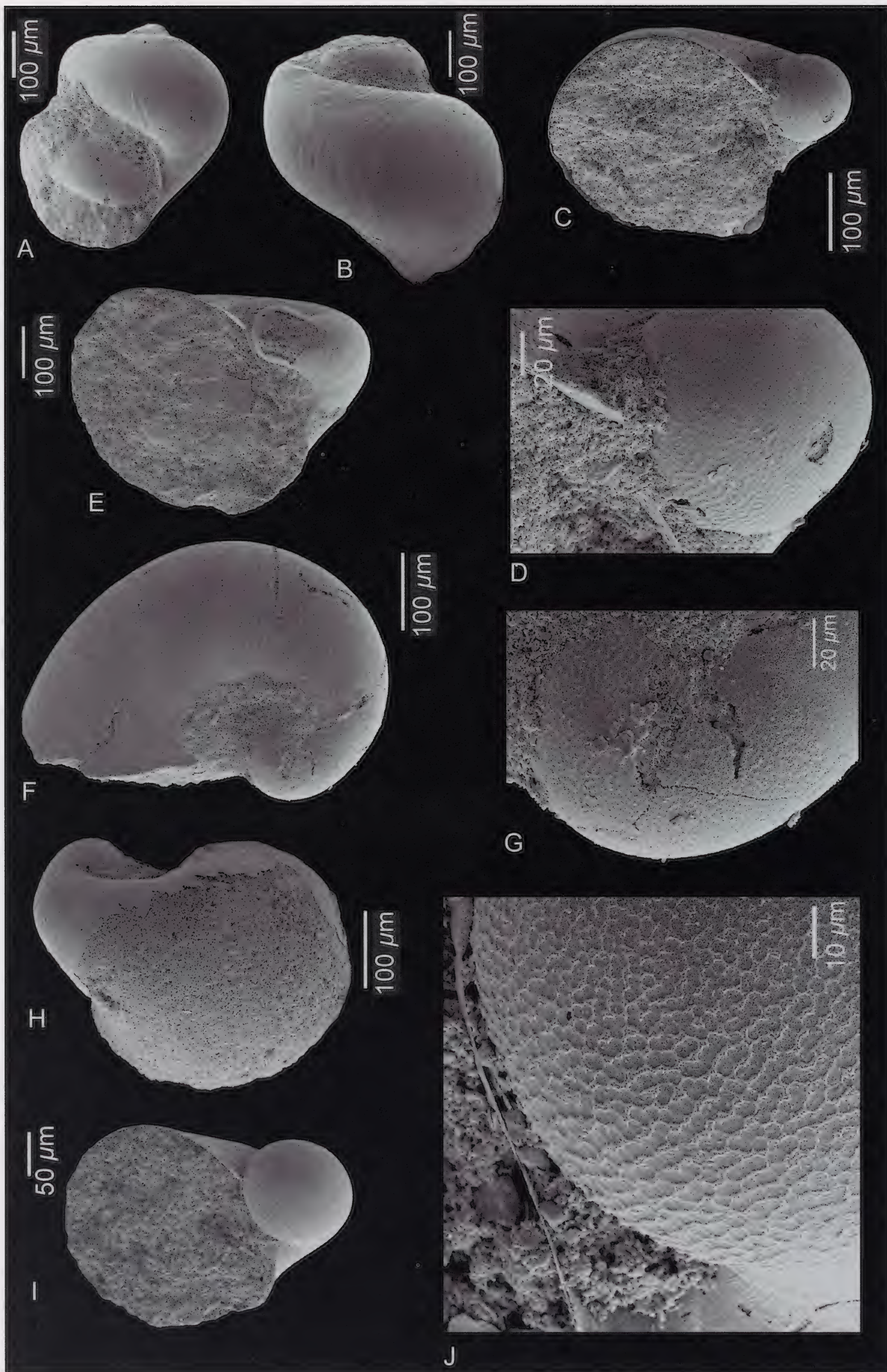




**Fig. 52. A-G.** *Gleba cordata* Niebuhr, 1776. Core T87/2/20G, sample 2.33-2.34 m, RGM 569.158a-g. **A.** Apertural view. **B, C, E.** Apical views. **D, F, G.** Umbilical views. **H-J.** *Peracle diversa* (Monterosato, 1875). Meteor 25, sta 37, Kg 1, RGM 541.630-630a. **H.** Eroded specimen, apertural view. **I.** Dorsal view. **J.** Ornament on early whorls, magnified.

**Fig. 52. A-G.** *Gleba cordata* Niebuhr, 1776. Carota T87/2/20G, campione 2.33-2.34 m, RGM 569.158a-g. **A.** Vista aperturale. **B, C, E.** Viste apicali. **D, F, G.** Viste umbilicali. **H-J.** *Peracle diversa* (Monterosato, 1875). Meteor 25, stazione 37, Kg 1, RGM 541.630-630a. **H.** Esemplare eroso, vista aperturale. **I.** Vista dorsale. **J.** Dettaglio della scultura sui primi giri.

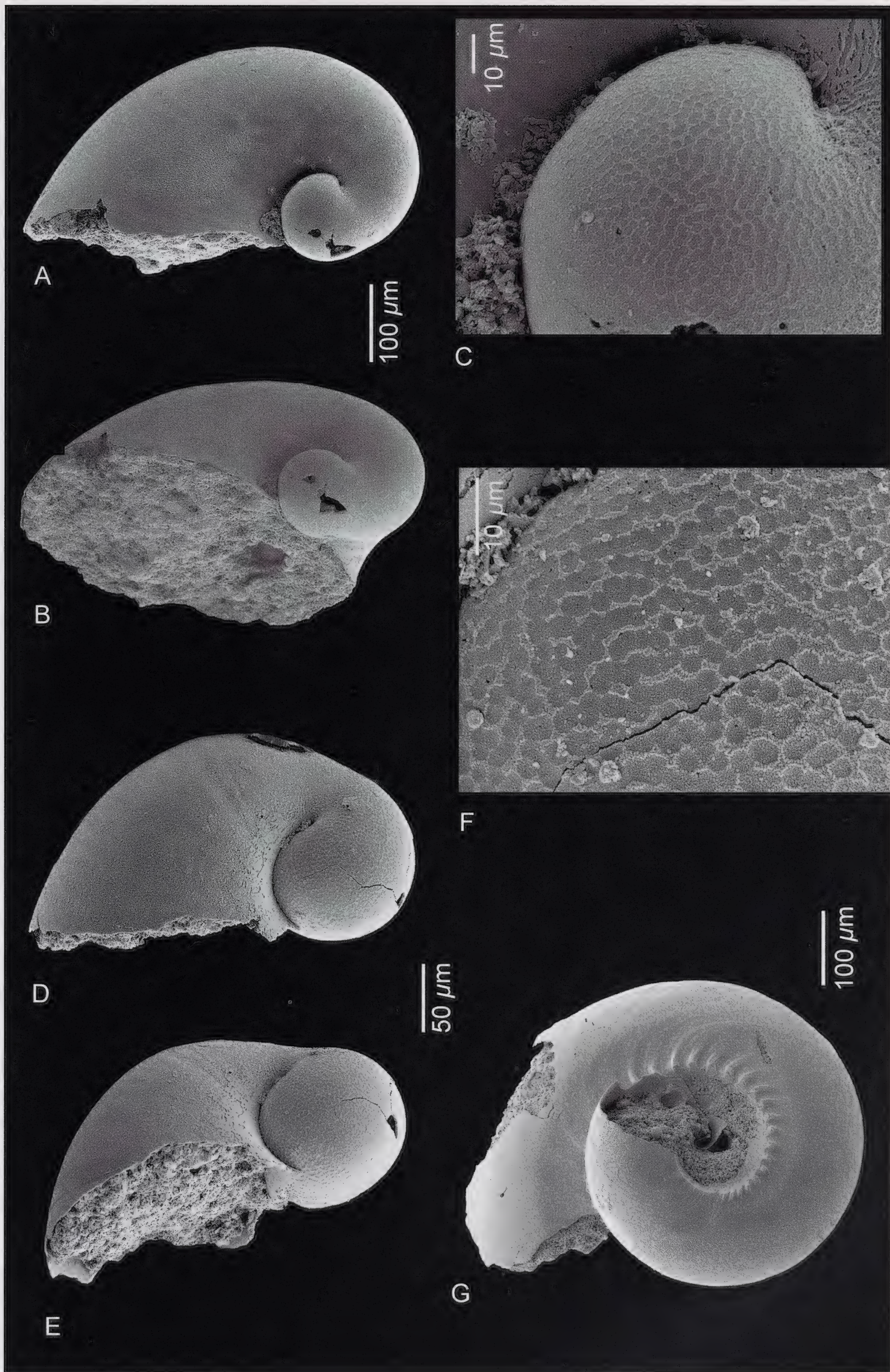




**Fig. 53.** **A, B.** *Peracle reticulata* (d'Orbigny, 1834). Juveniles, core T87/2/20G, sample 2.24-2.25 m, RGM 569 194a. **A.** Apertural view. **B.** Dorsal view. **C-J.** *Peracle?* sp. **C-H.** Core T87/2/20G, sample 2.33-2.34 m, RGM 569 160a-d. **C.** Apertural view. **D.** Nucleus magnified. **E.** Apertural view. **F.** Apical view. **G.** Nucleus magnified. **H.** Dorsal view. **I, J.** Core T87/2/20G, sample 2.30-2.31 m, RGM 569 174a. **I.** Apertural view. **J.** Nucleus magnified.

**Fig. 53.** **A, B.** *Peracle reticulata* (d'Orbigny, 1834). Juvenili, carota T87/2/20G, campione 2.24-2.25 m, RGM 569 194a. **A.** Vista aperturale. **B.** Vista dorsale. **C-J.** *Peracle?* sp. **C-H.** Carota T87/2/20G, campione 2.33-2.34 m, RGM 569 160a-d. **C.** Vista aperturale. **D.** Dettaglio del nucleo. **E.** Vista aperturale. **F.** Vista apicale. **G.** Dettaglio del nucleo. **H.** Vista dorsale. **I, J.** Carota T87/2/20G, campione 2.30-2.31 m, RGM 569 174a. **I.** Vista aperturale. **J.** Dettaglio del nucleo.

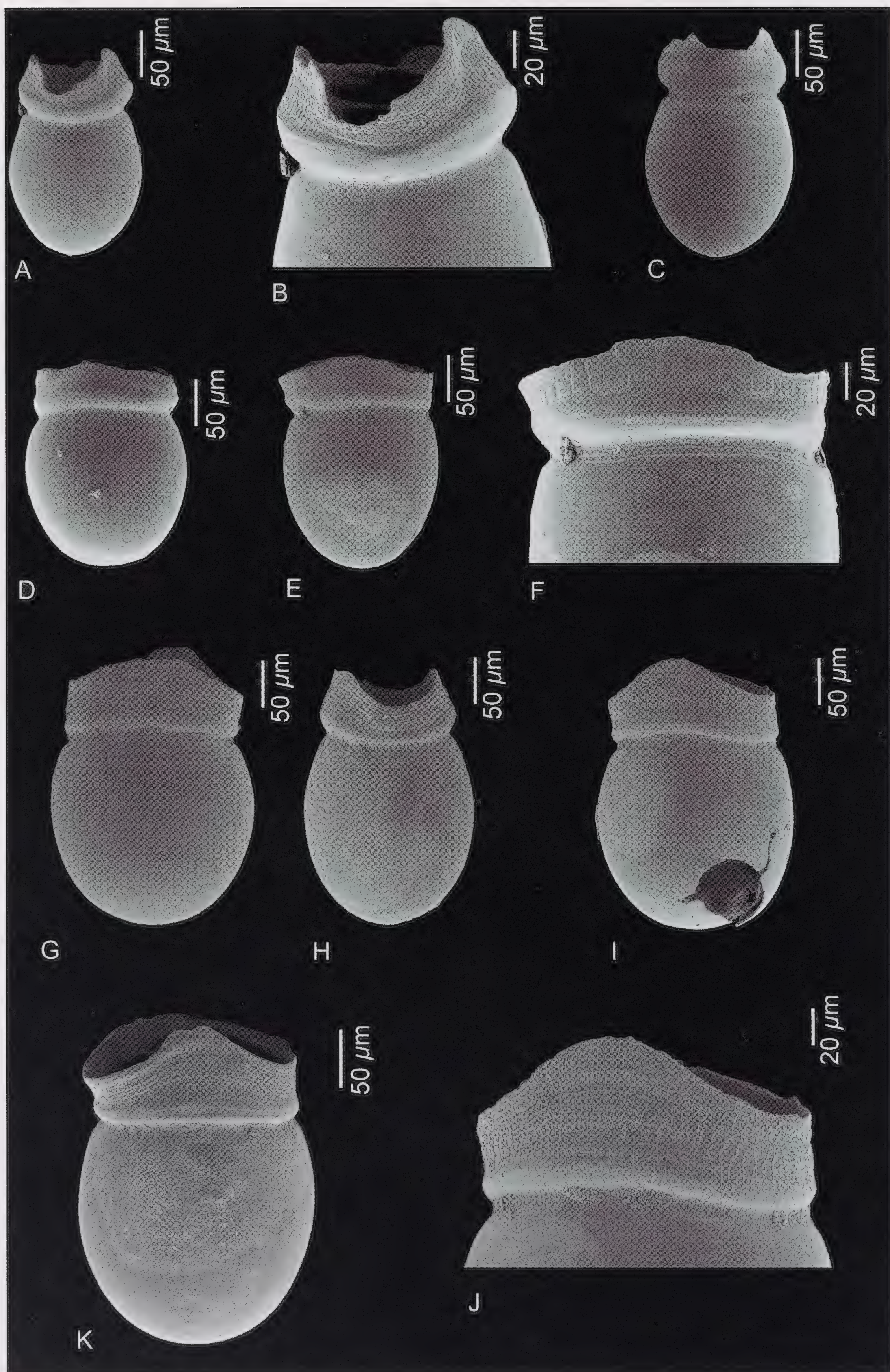




**Fig. 54. A-F.** *Peracle? sp.* Core T87/2/20G, sample 2.30-2.31 m RGM 569.174b-c. **A.** Apical view. **B.** Oblique apertural view. **C.** Nucleus magnified. **D.** Apical view. **E.** Oblique apertural view. **F.** Nucleus magnified. **G.** *Peracle diversa* (Monterosato, 1875). Core T87/2/20G, sample 2.24-2.25 m, RGM 569.196; apical view.

**Fig. 54. A-F.** *Peracle? sp.* Carota T87/2/20G, campione 2.30-2.31 m RGM 569.174b-c. **A.** Vista apicale. **B.** Vista aperturale obliqua. **C.** Dettaglio del nucleo. **D.** Vista apicale. **E.** Vista aperturale obliqua. **F.** Dettaglio del nucleo. **G.** *Peracle diversa* (Monterosato, 1875). Carota T87/2/20G, campione 2.24-2.25 m, RGM 569.196; vista apicale.





**Fig. 55. A-F.** Genus *Clionidarum* sp. 1. Core T87/2/20G, sample 1.68-1.69 m, RGM 569 321c-f. **A.** Lateral view. **B.** Apertural part magnified. **C.** Lateral view. **D.** Frontal view. **E.** Frontal view. **F.** Apertural part magnified. **G-K.** Genus *Clionidarum* sp. 2. **G.** Core T87/2/20G, sample 2.33-2.34 m, RGM 569 162a; frontal view. **H-J.** Core T87/2/20G, sample 2.24-2.25 m, RGM 569 200a-b. **H.** Lateral view. **I.** Frontal view. **J.** Apertural part magnified. **K.** Core T87/2/20G, sample 0.05-0.06 m, RGM 569. 404a; frontal view.

**Fig. 55. A-F.** Genus *Clionidarum* sp. 1. Carota T87/2/20G, campione 1.68-1.69 m, RGM 569 321c-f. **A.** Vista laterale. **B.** Dettaglio aperturale. **C.** Vista laterale. **D.** Vista frontale. **E.** Vista frontale. **F.** Dettaglio aperturale. **G-K.** Genus *Clionidarum* sp. 2. **G.** Carota T87/2/20G, campione 2.33-2.34 m, RGM 569 162a; vista frontale. **H-J.** Carota T87/2/20G, campione 2.24-2.25 m, RGM 569 200a-b. **H.** Vista laterale. **I.** Vista frontale. **J.** Dettaglio aperturale. **K.** Carota T87/2/20G, campione 0.05-0.06 m, RGM 569. 404a; vista frontale.

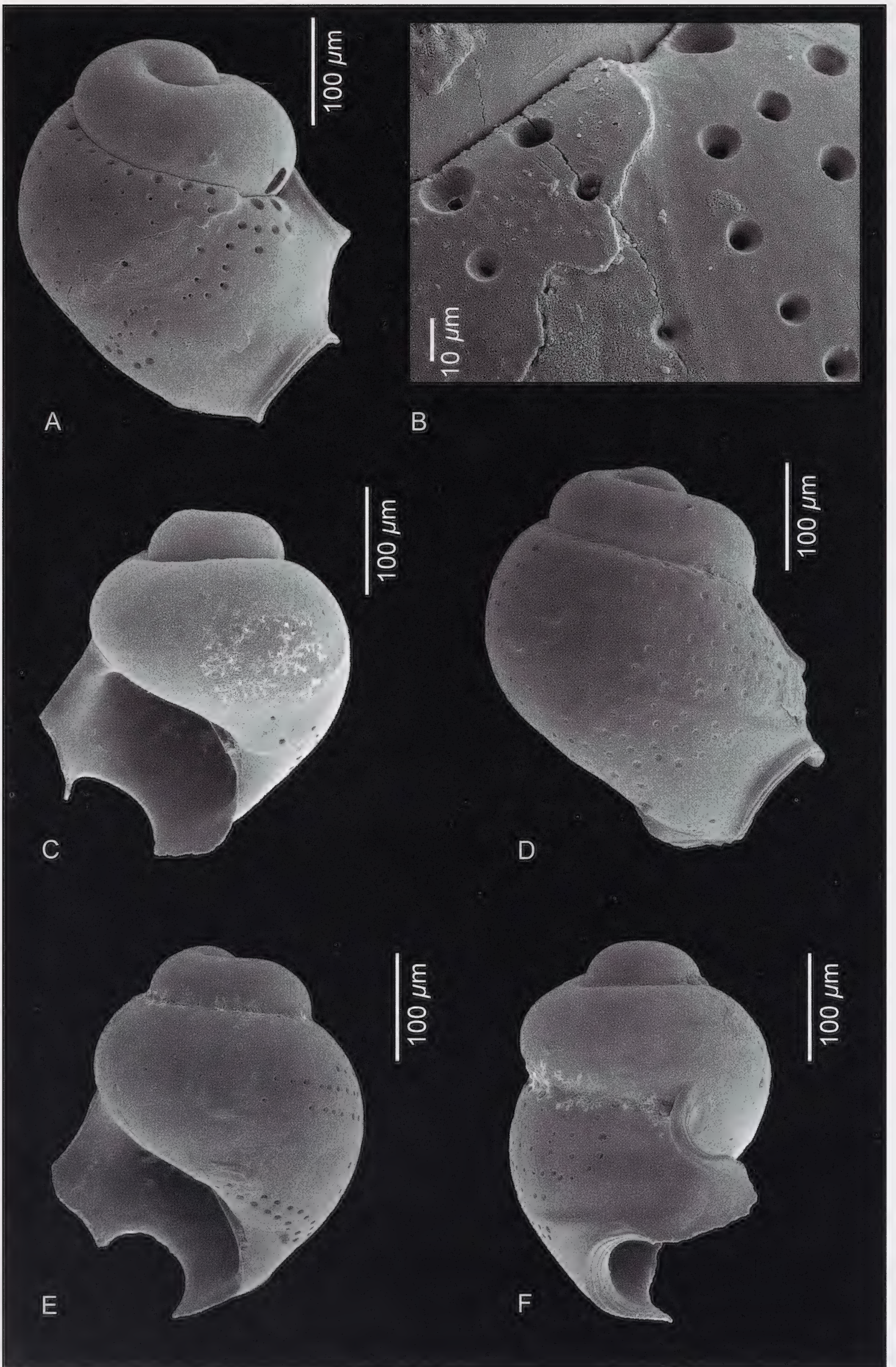




**Fig. 56.** **A-C.** Genus *Clionidarum* sp. 3. Core T87/2/20G, sample 2.33-2.34 m, RGM 569.163a-b. **A.** Frontal view. **B.** Microornament at apertural side. **C.** Frontal view. **D, E.** Genus *Clionidarum* sp. 4. Core T87/2/20G, sample 2.21-2.22 m, RGM 569.224. **D.** Frontal view (protoconch-1 damaged). **E.** Microornament at base of early teleoconch. **F-J.** Beaked larva, sensu van der Spoel & Newman, 1990. **F, G.** Core T87/2/20G, sample 2.36-2.37 m, RGM 569.145a-b. **F.** Apical fragment with protoconch. **G.** Apertural fragment, showing 'beak'. **H, I.** Core T87/2/20G, sample 2.33-2.34 m, RGM 569.164a. **H.** Apical fragment retaining protoconch. **I.** Microornament on early teleoconch. **J.** Core T87/2/20G, sample 0.05-0.06 m, RGM 569.406; apertural fragment.

**Fig. 56.** **A-C.** Genus *Clionidarum* sp. 3. Carota T87/2/20G, campione 2.33-2.34 m, RGM 569.163a-b. **A.** Vista frontale. **B.** Microscultura in prossimità dell'apertura. **C.** Vista frontale. **D, E.** Genus *Clionidarum* sp. 4. Carota T87/2/20G, campione 2.21-2.22 m, RGM 569.224. **D.** Vista frontale (protoconca-1 danneggiata). **E.** Microscultura alla base della teleoconca. **F-J.** Larva rostrata, sensu van der Spoel & Newman, 1990. **F, G.** Carota T87/2/20G, campione 2.36-2.37 m, RGM 569.145a-b. **F.** Frammento apicale con protoconca. **G.** Frammento aperturale con il "rostro". **H, I.** Carota T87/2/20G, campione 2.33-2.34 m, RGM 569.164a. **H.** Frammento apicale con protoconca. **I.** Microscultura sulla parte giovane della teleoconca. **J.** Carota T87/2/20G, campione 0.05-0.06 m, RGM 569.406; frammento aperturale.





**Fig. 57.** Veliger of benthic species? **A-C.** Core T87/2/20G, sample 2.18-2.19 m, RGM 569.241a-b. **A.** Lateral view. **B.** Part of body whorl magnified, showing perforations. **C.** Apertural view. **D-F.** Core T87/2/20G, sample 1.70-1.71 m, RGM 569.312a-c. **D.** Dorsal view. **E.** Apertural view. **F.** Lateral view.

**Fig. 57.** Stadi veliger di specie bentoniche? **A-C.** Carota T87/2/20G, campione 2.18-2.19 m, RGM 569.241a-b. **A.** Vista laterale. **B.** Dettaglio dell'ultimo giro, con perforazioni. **C.** Vista aperturale. **D-F.** Carota T87/2/20G, campione 1.70-1.71 m, RGM 569.312a-c. **D.** Vista dorsale. **E.** Vista aperturale. **F.** Vista laterale.



## References

- ABBOTT R.T., 1954. *American seashells*. Van Nostrand Reinhold Co., New York, etc.: 1-541.
- ALMOGI-LABIN A., 1982. Stratigraphic and paleoceanographic significance of Late Quaternary pteropods from deep-sea cores in the Gulf of Aqaba (Elat) and northernmost Red Sea. *Marine Micropaleontology*, **7**: 53-72.
- ALMOGI-LABIN A. & REISS Z., 1977. Quaternary pteropods from Israel, 1. Holocene and Pleistocene pteropods from the Mediterranean continental shelf and slope of Israel; 2. Pteropods from Recent sediments in the Gulf of Elat. *Revista Española de Micropaleontología*, **9**: 5-48.
- AVNIMELECH M., 1945. Revision of fossil Pteropoda from southern Anatolia, Syria and Palestine. *Journal of Paleontology*, **19**: 637-647.
- BANDEL K. & HEMLEBEN C., 1987. Jurassic heteropods and their modern counterparts (planktonic Gastropoda, Mollusca). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **174**: 1-22.
- BANDEL K. & HEMLEBEN C., 1995. Observations on the ontogeny of thecosomatous pteropods (holoplanktic Gastropoda) in the southern Red Sea and Bermuda. *Marine Biology*, **124**: 225-243.
- BATISTI M., JASPRICA N., CARI M. & LUI D., 2007. Annual cycle of the gelatinous invertebrate zooplankton of the eastern South Adriatic coast (NE Mediterranean). *Journal of Plankton Research*, **29**: 671-686.
- BAUCHOT M.L., WHITEHEAD P.J.P. & MONOD TH., 1982. Date of publication and authorship of the fish names in Eydoux & Souleyet's Zoology of La Bonite, 1841-1852. *Cybium*, **6**: 59-73.
- BÉ A.W.H. & GILMER R.W., 1977. A zoogeographic and taxonomic review of euthecosomatous Pteropoda. In: A.T.S. Ramsay (ed.). *Oceanic micropaleontology*, **1**. Academic Press, London: 733-807.
- BEDULLI D., CATTANEO-VIETTI R., CHEMELLO R., GHISOTTI F. & GIOVINE F., 1995. Gastropoda Opisthobranchia, Divasibranchia, Gymnomorpha, Fascicolo 15. In: MINELLI A., RUFFO A. & LA POSTA S (eds). *Checklist delle specie fauna italiana*. Bologna, Calderini: 1-26.
- BENOIT L., 1843. Ricerche malacologiche. *La Farfalletta. Opera periodica Scientifica Letteraria Artistica*, Dispensa XI e XVI, nuova serie: 3-12.
- BENSON W.H., 1835. Account of *Oxygyrus*; a new genus of pelagian shells allied to the genus *Atlanta* of Lesueur, with a note on some other pelagian shells lately taken on board the ship Malcolm. *The Journal of the Asiatic Society of Bengal*, **4**: 173-176.
- BERDAR A., GIACOBBE S. & LEONARDI M., 1982. Prima segnalazione per il Mediterraneo di *Corolla spectabilis* Dall, 1871 (Thecosomata). *Bollettino Malacologico*, **18**: 35-40.
- BERNARD F., 1955. Densité du plancton vu au large de Toulon depuis le bathyscaphe F.N.R.S. III. *Bulletin de l'Institut Océanographique (Fondation Albert 1er, prince de Monaco)*, **1063**: 1-16.
- BERTOLASO L. & PALAZZI S., 2000. Note sulla raccolta Seguenza di molluschi plio-pleistocenici della provincia di Messina conservata presso il Museo di Geologia e Paleontologia dell'Università di Firenze. *Bollettino Malacologico*, **35**: 3-44.
- BIEKART J.W., 1989. Euthecosomatous pteropods as paleohydrological and paleoecological indicators in a Tyrrhenian deep-sea core. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **71**: 205-224.
- B[LAINVILLE H.M.D.] DE, 1817. Carinaire. *Carinaria* (Malacoz.). *Dictionnaire des Sciences naturelles*, **7**: 105-108.
- B[LAINVILLE H.M.D.] DE, 1821. Hyale, *Hyalæa* (Malacoz.). *Dictionnaire des Sciences naturelles*, **22**: 65-83.
- B[LAINVILLE H.M.D.] DE, 1822. Janthine. *Janthina* (Malacozol.). *Dictionnaire des Sciences Naturelles*, **24**: 148-155.
- B[LAINVILLE H.M.D.] DE, 1824. Mollusques, Mollusca (Malacoz.). *Dictionnaire des Sciences naturelles*, **32**: 1-392.
- BLAINVILLE, H.M. DUCROTAY DE, 1825-1827. *Manuel de malacologie et de conchyliologie; contenant: 1e Une histoire abrégée de cette partie de la zoologie; des considérations générales sur l'anatomie, la physiologie et l'histoire naturelle des malacozoaires, avec un catalogue des principaux auteurs qui s'en sont occupés. 2e Des principes de conchyliologie, avec une histoire abrégée de cet art et un catalogue raisonné des auteurs principaux qui en traitent. 3e Un système général de malacologie tiré à la fois de l'animal et de sa coquille, dans une dépendance réciproque, avec la figure d'une espèce de chaque genre*. Paris, Levrault): i-viii, 1-648 (1825); 649-664 (Nouvelles additions et corrections au genera) (1827); atlas 109 pls, 1827.
- BLANC-VERNET L., CHAMLEY H. & FROGET C., 1969. Analyse paléoclimatique d'une carotte de Méditerranée nord-occidentale. Comparaison entre les résultats de trois études: foraminifères, ptéropodes, fraction sédimentaire issue du continent. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **6**: 215-235.
- BLANCKENHORN M., 1889. Pteropodenreste aus der oberen Kreide nord-syriens und aus dem hessischen Oligocän. *Zeitschrift der geologischen Gesellschaft*, **61**: 593-602.
- BLEEKER J. & SPOEL S. VAN DER, 1988. *Diacria piccola* and *Diacria maculata*: two new pteropod mollusc species from the Atlantic and Pacific oceans. *Proceedings of the Biological Society of Washington*, **101**: 60-66.
- BOAS J.E.V., 1886. *Spolia atlantica*. Bidrag til pteropodernes. Morfologi og Systematik samt til Kundskaben om deres geografiske Udbredelse. *Videnskabernes Selskabs Skrifter*, **6** (naturvidenskabelig og matematisk Afdeling), **4**: 1-231.
- BONNEVIE K., 1913 (reprinted 1933). Pteropoda from the Michael Sars North-Atlantic deep-sea expedition. *Report on the Scientific Results of the 'Michael Sars' North Atlantic Deep-Sea Expedition 1910*, **3**: 1-69.
- BONTES B. & SPOEL S. VAN DER, 1998. Variation in the *Diacria trispinosa* group, new interpretation of colour patterns and description of *D. rubecula* n. sp. (Pteropoda). *Bulletin Zoologisch Museum, Universiteit van Amsterdam*, **16**: 77-84.
- BOSC L.A.G., 1802 ('an x'). *Histoire naturelle des coquilles, contenant leur description, les mœurs des animaux qui les habitent et leurs usages*, **2**. Deterville, Paris: i-iii, 1-330.
- BOSCH D.T., DANCE S.P., MOOLENBEEK R.G., OLIVER P.G., 1995. *Seashells of Eastern Arabia*. Motivate Publishing, Dubai-Abu Dhabi, London: 1-296.
- BOTTEMA S., VAN STRAATEN L.M.J.U., 1966. Malacology and palynology of two cores from the Adriatic sea floor. *Marine Geology*, **4**: 553-564.
- BOUCHET P., ROCROI J.-P., 2005. Classification and nomenclator of gastropod families. *Malacologia*, **47**: 1-397.
- BOUCHET, P. & RÜTZLER, K., 2003. Clionidae d'Orbigny, 1851 (Porifera, Hadromerida): proposed emendment of spelling to Clionaidae to remove homonymy with Clionidae Rafinesques, 1815 (Mollusca, Pteropoda). *Bulletin of Zoological Nomenclature*, **60**: 99-102.
- BOWDICH T.E., 1822. *Elements of conchology, including the fossil genera and the animals*, **1**. Univalves. Paris, Smith: i-xi, 13-75 (referred to in van der Spoel, 1967 with the year 1820).
- BROWNE P., 1756. The civil and natural history of Jamaica in three parts., Osborne & Shipton, London: i-viii, 506 pp.
- BUCCHERI G., 1978. Pteropoda Euthecosomata ed Heteropoda (Mollusca, Gastropoda) in sedimenti batiali pleistocenici della East Yucatan Scarp (Mar dei Caraibi). *Bollettino della Società Paleontologica Italiana*, **17**: 118-141.
- BUCCHERI G., 1979. Pteropoda ed Heteropoda (Mollusca, Gas-



- tropoda) del Pleistocene inferiori (Siciliano) della Sicilia. *Lavori Istituto di Geologia, Università di Palermo*, **15**: 1-34.
- BUCCHERI G., 1983. Osservazioni paleoclimatiche sul Siciliano della Sicilia occidentale. La sezione della località tipo di Ficcarazzi (Palermo). *Rendiconti della Società Geologica Italiana*, **5**: 51-54.
- BUCCHERI G., 1984. Pteropods as climatic indicators in Quaternary sequences: a Lower-Middle Pleistocene sequence outcropping in Cava Puleo (Ficarazzi, Palermo, Sicilia). *Palaeogeography, Palaeoclimatology, Palaeoecology*, **45**: 75-86.
- BUCCHERI G., 1985. Osservazioni paleoclimatiche al limite Pleistocene inferiore-Pleistocene medio della foce del Belice (Sicilia sud-occidentale) mediante l'uso degli pteropodi. *Bollettino della Società Geologica Italiana*, **104**: 115-122.
- BUCCHERI G., BERTOLDO M., 1992. Le associazioni a pteropodi del Pleistocene mediterraneo, 2. Analisi paleoclimatica della carote nn. 1, 2 e 3 del Pozzo DSDP 132 (Leg 13). *Bollettino della Società Geologica Italiana*, **111**: 493-511.
- BUCCHERI G., CATALANO R., HEEZEN B., 1980. Pleistocene pteropod limestones dredged from the East Yucatan Scarp. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **30**: 97-105.
- BUCCHERI G., RUSSO B., BERTOLDO M., 1994. Stratigrafia e paleoclimatologia della carota GN82-C41 (Mar Tirreno): foraminiferi e pteropodi. *Bollettino della Società Geologica Italiana*, **113**: 127-155.
- BUCCHERI G., STEFANO E. DI, 1984. Contributo allo studio del Golfo di Pozzuoli. Pteropodi e nannoplancton calcareo contenuti in tre carote: considerazioni ambientali e biostratigrafiche. *Memorie della Società Geologica Italiana*, **27**: 181-193.
- BUCCHERI G., TORELLI L., 1981. Stratigraphy and paleoclimatic evaluations of the cores BS77-15 and BS77-33 (Sardinia Basin, western Tyrrhenian Sea) by means of pteropod assemblages. *Ateneo Parmense, Acta Naturalia*, **17**: 73-94.
- BUCQUOY E., DAUTZENBERG P. & DOLLFUS G., 1886. *Les mollusques marins du Roussillon*, 1. Gastropodes, 11. Baillière, Paris: 419-454.
- CALDARA M., D'ALESSANDRO A., DI GERONIMO I., 1981. Paleo-comunità circolatorie del Pleistocene di Gallipoli (Lecce). *Bollettino Malacologico*, **17**: 125-164.
- CANTRAINE F., 1835. Notice contenant les diagnoses ou descriptions succinctes de quelques espèces nouvelles de mollusques. *Bulletin de l'Académie royal des Sciences et Belles Lettres de Bruxelles*, **2**: 380.
- CANTRAINE F., 1841. Malacologie méditerranéenne et litorale, ou description des mollusques qui vivent dans la Méditerranée ou sur le continent de l'Italie, ainsi que des coquilles qui se trouvent dans les terrains tertiaires italiens, avec des observations sur leur anatomie, leurs mœurs, leur analogie et leur gisement. Ouvrage servant de faune malacologique italienne et de complément à la Conchiologia fossile subappennina de Brocchi. *Mémoires de l'Académie royale de Bruxelles*, **13**: 1-173.
- CARUS J.V., 1890. *Prodromus faunae mediterraneae sive descriptio animalium maris mediterranei incolarum quam comparata silva rerum quatenus innotuit adiectis locis et nominibus vulgaribus eorumque auctoribus in commodum zoologorum*, 2 (2). Mollusca. Cephalopoda. Tunicata. Schweizerbart, Stuttgart: 273-496.
- ÇEVİK C., KIDEYS A., TOKLU B., ERGÜDEN D. & SARIHAN E., 2006. New pelagic Gastropoda species encountered on the Turkish coast of the Levant Sea. *Turkish Journal of Veterinary and Animal Science*, **30**: 151-157.
- CHECCHIA-RISPOLI G., 1921. I pteropodi del Miocene garganico. *Bollettino del Reale Comitato Geologico d'Italia*, **48** (1920-1921): 1-28.
- CHEMNITZ J.H., 1786. *Neues systematisches Conchylien-Cabinet*, 9 (1) enthaltend die ausführliche Beschreibung von den Linksschnecken oder von den verkehrtgewundenen Conchylien welche gegen die Gewohnheit aller übrigen ihre Mundöffnungen nicht auf der rechten, sondern auf der linken Seite haben. G.N. Raspe, Nürnberg: 16 pp. unnumbered, 1-151, pls 103-116.
- CHEN C., 1968. Pleistocene pteropods in pelagic sediments. *Nature*, **219** (5159): 1145-1149.
- CHEN C., BÉ A.W.H., 1964. Seasonal distribution of euthecosomatous pteropods in the surface waters of five stations in the western North Atlantic. *Bulletin of Marine Science of the Gulf and Caribbean*, **14**: 185-220.
- [CHILDREN, J.G.], 1823. Lamarck's genera of shells. *The Quarterly Journal of Science, Literature, and the Arts*, **15**: 216-258 (published anonymously).
- CHIAJE S. DELLE, 1822-1830. *Memorie sulla storia e notomia degli animali senza vertebre del regno di Napoli*. Figure, Napoli: 109 pls.
- Note: Although the atlas is dated 1822 this seems to be incorrect at least for a number of plates (nrs 70-84, 86-109) on which the date 1830 is inserted at the base of the plate by the artist.
- CHUN C., 1889. Bericht über eine nach den Canarischen Inseln im Winter 1887/1888 ausgeführte Reise. *Sitzungsberichte der königlichen preussischen Akademie der Wissenschaften zu Berlin*, **1889-2**: 519-553.
- CLEMAM, 2011. *Checklist of European Marine Mollusca*. <http://www.somali.asso.fr/clemam/index.php>.
- COLANTONI P., PADOVANI A. & TAMPIERI R., 1970. Ricerche geologiche preliminari nel Mar Tirreno. Crociera CST 68 del Laboratorio di Geologia Marina del CNR-Bologna, 11. Molluschi. *Giornale di Geologia*, **37**: 163-188.
- COLLINS R.L., 1934. A monograph of the American Tertiary pteropod mollusks. *Johns Hopkins University Studies in Geology*, **11**: 137-234.
- CORSELLI C. & GRECCHI G., 1987. Considerazioni su di una popolazione di *Cavolinia gibbosa gibbosa* del Mediterraneo orientale. *Bollettino Malacologico*, **23**: 83-91.
- CORSELLI C. & GRECCHI G., 1990. Considerazioni sui Thecosomata attuali del Bacino Mediterraneo. *Lavori della Società Italiana di Malacologia*, **24**: 120-130.
- COSTA O., 1829. Note sur le carinaire vitrée, accompagnant un dessin fait d'après nature sur un individu vivant. *Annales des Sciences Naturelles*, **16**: 107-109.
- DALL W.H., 1871. Descriptions of sixty new forms of mollusks from the west coast of North America and the north Pacific Ocean, with notes on others already described. *American Journal of Conchology*, **7**: 93-160.
- DANCE S.P., 1986. A history of shell collecting. Backhuys, Leiden: i-xv, 1-265.
- DELL R.K., 1957. A revision of the recent scaphopod Mollusca of New Zealand. *Transactions of the Royal Society of New Zealand*, **84**: 561-567.
- DESHAYES G.P., 1839-1853. *Traité élémentaire de conchyliologie avec les applications de cette science à la géologie. Explication des planches*. Paris, V. Masson: 1-8 (1839), 9-48 (1850), 49-80 (1853).
- DIESTER-HAASS L. & SPOEL S. VAN DER, 1978. Late Pleistocene pteropod-rich sediment layer in the northeast Atlantic and protoconch variation of *Clio pyramidata* Linné 1767. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **24**: 85-109.
- DI GERONIMO I., 1970. Heteropoda e Pteropoda Thecosomata in sedimenti abissali recenti dello Jonio. *Thalassia Salentina*, **4**: 41-115.
- DI GERONIMO I., 1974a. *Hyalocylis obtusa* n. sp. (Pteropoda, Thecosomata) in sedimenti abissali recenti dello Jonio. *Conchiglie*, **10**: 113-116.
- DI GERONIMO I., 1974b. Molluschi bentonici in sedimenti recenti batiali e abissali dello Jonio. *Conchiglie*, **10**: 133-172.
- DUNKER W., 1875. Ueber Conchylien von Desterro, Provinz



- Sta. Catharina, Brasilien. *Jahrbücher der Deutschen Malakozoologischen Gesellschaft*, 2: 240-254.
- DUPONT L., 1979. Note on variation in *Diacria* Gray, 1847, with descriptions of a species new to science, *Diacria rampali* nov. spec., and a forma new to science, *Diacria trispinosa* forma *atlantica* nov. forma. *Malacologia*, 18: 37-52.
- ESCHSCHOLTZ F., 1825. Bericht über die zoologische Ausbeute während der Reise von Kronstadt bis St. Peter und Paul. *Isis* (1825), 6: 733-747.
- ETI, 2011. *Marine species identification portal*. <http://species-identification.org/>.
- EYDOUX [J.F.T.] & SOULEYET [L.F.A.], 1841 (?). *Voyage autour du monde exécuté pendant les années 1836 et 1837 sur la corvette 'La Bonite', commandée par M. Vaillant, capitaine de vaisseau, publié par ordre du Gouvernement sous les auspices du Département de la marine. Histoire Naturelle, Zoologie. Atlas. A. Bertrand, Paris: 8 pp., mammifères pls 1-12, oiseaux pls 1-10, reptiles pls 1-10, poissons pls 1-10, crustacés pls 1-5, insectes pls 1-2, mollusques pls 1-15, 15bis, 16-23, 23bis, 24, 24bis, 24A-E, 25-45, zoophytes pls 1-2, vers pl. 1.*  
Note: The atlas was published undated and only vernacular names were given. Smith (1888) and van der Spoel (1976, implicitly, see e.g. p. 207) referred to the atlas with the year 1841. According to Tesch (1908: p. 25, footnote) the atlas appeared in 1842. Sherborn & Woodward (1901: 391) mentioned as publication date '1846-1849?'. Also Bauchot et al. (1982) were not able to date the atlas with certainty. Dance (1986: p. 237) cited atlas, text together as 1841-1852. Here the date 1841 is maintained, but with a query.
- FISCHER P., 1882. Diagnoses d'espèces nouvelles de mollusques recueillis dans la cours des expéditions scientifiques de l'avis le Travailleur (1880 et 1881). *Journal de Conchyliologie*, 30: 49-53.
- FLEMING J., 1823. On a reversed species of *Fusus*, (*Fusus retroversus*). *Memoirs of the Wernerian Natural History Society*, 4: 498-500.
- FORBES E., 1844. Report on the Mollusca and Radiata of the Aegean Sea, and on their distribution, considered as bearing on geology. *Report of the Thirteenth Meeting of the British Association for the Advancement of Science, held at Cork in August 1843* (1843): 131-193.
- FORSKÅL P., 1775. *Descriptiones animalium avium, amphibiorum, piscium, insectorum, vermium; quae in itinere Orientali observavit Petrus Forskål, prof. Haun. Post mortem autoris edidit Carsten Niebuhr. Adjuncta est materia medica Kahirina atque tabula Maris Rubri geographica*. Möller, Hauniae: 1-20, i-xxxv, 1-164.  
Note: Taxa from this paper are frequently cited with the authorship of Niebuhr, or Fors(s)kål in Niebuhr. Here the recommendation of Welter-Schultes (2011: p. 45) is followed.
- FRANC A. 1948. Véligères et mollusques gastéropodes des Baies d'Alger et de Banyuls. *Journal de Conchyliologie*, (4)88: 13-35
- FRANC A. 1949. Hétéropodes et autres gastropodes planctoniques de Méditerranée occidentale. *Journal de Conchyliologie*, (4)89: 209-230.
- FROGET C., 1967. Les ptéropodes dans les sédiments sous-marins du Quaternaire: caractérisation du régime 'Nord-Atlantique' au cours des périodes glaciaires en Méditerranée par le ptéropode *Spiratella retroversa* Fleming. *Comptes rendus hebdomadaires des Séances de l'Académie des Sciences*, D264 (26): 2968-2969.
- FROGET C. & PASTOURET L., 1972. Les ptéropodes, moyen d'étude de la climatologie quaternaire. Comparaison de deux carottes prélevées en Méditerranée occidentale et orientale. *Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranéenne, Monaco. Rapports et Procès-Verbaux des Réunions*, 20 (4): 611-614.
- GABB W.M., 1873. On the topography and geology of Santo Domingo. *Transactions of the American Philosophical Society*, (NS)15: 49-259.
- GAGLINI A. & VILLARI A., 1994. Priorità di *Peracle diversa* Monterosato, 1875 su *Peracle apicifulva* Meisenheimer, 1906. *Bollettino Malacologico*, 29: 307-310.
- GIOVINE F., 1987. Nomenclatural problems for two species of *Atlanta*. *La Conchiglia*, 19 (216-217): 22-23.
- GIOVINE F., 1988. The genus *Peracle* in the Mediterranean (Heterobranchia: Peraclidae). *La Conchiglia*, 20 (226-227): 22-24.
- GIOVINE F., in STOCH F. (ed.), 2003. *Checklist of the Italian fauna on-line*. <http://www.faunaitalia.it/checklist/introduction.html> (consulted March 2011).
- GMELIN F.J., 1791. *Caroli a Linné systema naturae per regna tria naturae, secundum classes, ordines, genera, species cum characteribus, differentis, synonymus, locis*. Editio XIII aucta reformata, 1 (6). Lipsiae: 3021-3910.
- GODEAUX J. & TOULEMONT A., 1990. A propos des migrations lessepsiennes. *Bulletin de l'Institut océanographique, Monaco, numéro spécial*, 7: 103-107.
- GOFAS S., LE RENARD J. & BOUCHET P., 2001. Mollusca. In: COSTELLO M.J., EMBLOW C., WHITE R. (eds). European register of marine species. A check-list of the marine species in Europe and a bibliography of guides to their identification. *Collection Patrimoines Naturel*, 50: 180-213.
- GOULD A.A., 1852. Mollusca & shells. *United States exploring expedition. During the years 1838, 1839, 1840, 1841, 1842. Under the command of Charles Wilkes, U.S.N.*, 12. Gould & Lincoln, Boston: i-xv, 1-510.
- GOULD A.A., 1856. Mollusca and shells. *United States exploring expedition. During the years 1838, 1839, 1840, 1841, 1842. Under the command of Charles Wilkes, U.S.N.* Sherman & Son, Philadelphia: Atlas 1-16, 52 pls.
- GRANDORI R., 1910. Sul materiale planktonico raccolto nella 2ª crociera oceanografica. *Bollettino del Comitato Talassografico*, 6: 6-26.
- GRAY J.E., 1847. A list of the genera of recent Mollusca, their synonyma and types. *Proceedings of the Zoological Society of London*, 15: 129-219.
- GRAY J.E. 1850. Explanation of plates. In: GRAY, M.E. *Figures of molluscan animals selected from various authors, etched for the use of students*, 4. Longman, Brown, Green & Longmans, London: i-iv, 1-124.
- GRAY J.E., 1855. *List of Mollusca and shells in the collection of the British Museum, collected and described by MM. Eydoux and Souleyet, in the "Voyage autour du monde" exécuté pendant les années 1836 et 1837, sur la Corvette 'La Bonite' and in the "Histoire naturelle des Mollusques Ptéropodes," par MM. P.-C.-A.-L. Rang et Souleyet*. British Museum, London: 1-27.
- GRAY M.E., 1842-1857. *Figures of molluscan animals selected from various authors; etched for the use of students*. Longman, Brown, Green & Longmans, London, 1: i-iv, 1-40, pls 1-78 (1842), 2: i-iv, pls 79-199 (1850), 3: i-iv, pls 200-312 (1850); 4: i-iv, 1-124 (Explanation of plates, by J.E. GRAY), 129-219 (List of the genera of Recent Mollusca, their synonyma and types, by J.E. GRAY) (1850, reprinted, with the original page numbers, from *Proceedings of the Zoological Society*, 15, 1847); 5: 1-49 (Explanation of pls 313-381 and Systematic arrangement of the figures, by J.E. GRAY), pls 313-381 (1857).
- GRECCHI G., 1982. Pteropodi pliocenici dell'Italia settentrionale. *Rivista Italiana di Paleontologia*, 87 (4): 703-738.
- GRECCHI G., 1984. Molluschi planctonici e bentonici in sedimenti sapropelitici del Quaternario della dorsale Mediterranea. *Bollettino Malacologico*, 20: 1-34.
- GRECCHI G., 1987. Revisione tassonomica degli esemplari fossili e subfossili di *Clio polita* rinvenuti in Mediterraneo e in Mar Rosso. *Bollettino Malacologico*, 23: 297-303.



- GRECCHI G. & BERTOLOTI M., 1988. Interpretazione paleoclimatica della carota CG18-BAN82 basata sull'analisi di Thecosomata Euthecosomata del Quaternario del Mediterraneo orientale. *Bollettino del Museo Regionale di Scienze Naturali, Torino*, **6**: 73-132.
- GUPPY R.J.L., 1882. On the Recent and Tertiary species of *Leda* and *Nucula* found in the Westindies: with notices of Westindian shells. *Proceedings of the Scientific Association of Trinidad*, (2) **4** (12): 168-180.
- HEMLEBEN C., 2002. Short cruise report, R.V. Meteor Cruise 51, Leg 3, November 14 - December 10, 2001, Valletta/Malta to Istanbul/Turkey: 4 pp.
- HERMAN Y., 1971a. Quaternary climate changes in the eastern Mediterranean as recorded by pteropods and planctonic Foraminifera. In: FARINACCI A. (ed.). Second International Plankton Conference. Proceedings. Tecno-Scienza, Roma: 611-622.
- HERMAN Y., 1971b. Vertical and horizontal distribution of pteropods in Quaternary sequences. In: FUNNELL B.M., RIEDEL W.R. (eds). Micropaleontology of oceans. Cambridge University Press, Cambridge: 463-486, 2 pls (copied from Herman & Rosenberg, 1971).
- HERMAN Y., 1973. Preliminary pteropod results from the Mediterranean Sea. *Initial Reports Deep Sea Drilling Project*, **13**: 993-1001.
- HERMAN Y., 1981. Paleoclimatic and paleohydrologic record of Mediterranean deep-sea cores based on pteropods, planktonic and benthonic foraminifers. *Revista Española de Micropaleontología*, **13**: 171-200.
- HERMAN Y. & ROSENBERG P.E., 1971. Pteropods as sea level indicators. In: TERS M. (ed.). Études sur le Quaternaire dans le monde. Union internationale pour l'Étude du Quaternaire. VIIIe Congrès INQUA, Paris 1969, 1: 187-190.
- HERRMANNSEN A.N., 1846-1849. *Indicis generum malacozoorum primordia. Nomina subgenerum, generum, familiarum, tribuum, ordinum, classium; adjunctis auctoribus, temporibus, locis systematicis atque literariis, etymis, synonymis. Praetermittuntur Cirripedia, Tunicata et Rhizopoda* 1-2. Theodori Fischeri, Cassellis: i-xxvii, 1-637, 1846 (1); i-xlii, 1-717, 1847-1849 (2).
- HILGERSOM P.C.J., SPOEL S. VAN DER, 1987. East-west variation in *Diacria* off northwestern Africa. *Malacological Review*, **20**: 97-104.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1999. *International Code of Zoological Nomenclature*. Fourth edition. The International Trust for Zoological Nomenclature, London: i-xxix, 1-306.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 2006. Opinion 2133 (Case 3211) Clionidae d'Orbigny, 1851 (Porifera, Hadromerida): emended to Clionaidae to remove homonymy with Clionidae Rafinesque, 1815 (Mollusca, Pteropoda). *Bulletin of Zoological Nomenclature*, **63**: 51-53.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 2009. Opinion 2216 (Case 3404). *Atlanta lesueurii* J.E. Gray, 1850 (Mollusca, Gastropoda, Pterotracheoidea, Atlantidae): specific name conserved. *Bulletin of Zoological Nomenclature*, **66**: 88-89.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 2011. OPINION 2266 (Case 3494) *Atlanta inflata* Gray, 1850 (Mollusca, Gastropoda, Pterotracheoidea, Atlantidae): specific name conserved. *Bulletin of Zoological Nomenclature*, **68**: 82-83.
- ISSEL R., 1911. Molluschi eteropodi raccolti dal Capitano G. Chierchia durante il viaggio di circumnavigazione delle R. Nave 'Vettor Pisani' negli anni 1882-83-84-85. *Annuario del Museo Zoologico della R. Università di Napoli*, (Nuova Serie) **3** (16): 1-11.
- ISSEL R., 1915. Atlantidae e Carinaria. *Memorie R. Comitato Talassografico Italiano*, **52**: 1-26.
- IVANOVA E.V., 1985. Late Quaternary biostratigraphy and paleotemperatures of the Red Sea and the Gulf of Aden based on planktonic Foraminifera and pteropods. *Marine Micropaleontology*, **9**: 335-364.
- JANSSEN A.W., 1990. Pteropoda (Gastropoda, Euthecosomata) from the Australian Cainozoic. *Scripta Geologica*, **91** (1989): 1-76.
- JANSSEN A.W., 1995. Systematic revision of holoplanktonic Mollusca in the collections of the 'Dipartimento di Scienze della Terra' at Torino, Italy. *Museo regionale di Scienze naturali, Torino, Monografie*, **17**: 1-233.
- JANSSEN A.W., 1999. Neogene paleontology in the northern Dominican Republic, 20. Holoplanktonic molluscs (Gastropoda: Heteropoda and Thecosomata). *Bulletins of American Paleontology*, **358**: 1-40.
- JANSSEN A.W., 2003. Notes on the systematics, morphology and biostratigraphy of fossil holoplanktonic Mollusca, 13. Considerations on a subdivision of Thecosomata, with the emphasis on genus group classification of Limacinidae. *Cainozoic Research*, **2**: 163-170.
- JANSSEN A.W., 2004. Holoplanktonic molluscan assemblages (Gastropoda, Heteropoda, Thecosomata) from the Pliocene of Estepona (Spain, Málaga). *Palaeontos*, **5**: 103-131.
- JANSSEN A.W., 2005. Development of Cuvierinidae (Mollusca, Euthecosomata, Cavolinioidea) during the Cainozoic: a non-cladistic approach with a re-interpretation of Recent taxa. *Basteria*, **69**: 25-72.
- JANSSEN A.W., 2007a. Holoplanktonic Mollusca (Gastropoda) from the Gulf of Aqaba, Red Sea and Gulf of Aden (Late Holocene-Recent). *The Veliger*, **49**: 140-195.
- JANSSEN A.W., 2007b. Holoplanktonic Mollusca (Gastropoda: Pterotracheoidea, Janthinoidea, Thecosomata and Gymnosomata) from the Pliocene of Pangasinan (Luzon, Philippines). *Scripta Geologica*, **135**: 29-177.
- JANSSEN A.W., in press. Systematics and biostratigraphy of holoplanktonic Mollusca from the Oligo-Miocene of the Maltese Archipelago. *Museo Regionale di Storia Naturale, Torino, Bollettino* (submitted).
- JANSSEN A.W., KING C. & STEURBAUT E., 2011. Notes on the systematics, morphology and biostratigraphy of fossil holoplanktonic Mollusca, 21. Early and Middle Eocene (Ypresian-Lutetian) holoplanktonic Mollusca (Gastropoda) from Uzbekistan. *Basteria*, **75**: 71-93.
- JANSSEN A.W. & PEIJNENBURG K.T.C.A., in press. Holoplanktonic Mollusca: development in the Mediterranean Basin during the last 30 Ma and their future. In: GOFFREDO S., BAADER H., DUBINSKY Z. (eds). *The Mediterranean Sea: Its History and Present Challenges*. Springer.
- JANSSEN A.W. & SEAPY R.R., 2007. Case 3404. *Atlanta lesueurii* Souleyet, 1852 (Mollusca, Gastropoda, Pterotracheoidea, Atlantidae): proposed conservation of the specific name. *Bulletin of Zoological Nomenclature*, **64** (4): 224-226.
- JANSSEN A.W. & SEAPY R.R., 2009a. Case 3494. *Atlanta inflata* Gray, 1850 (Mollusca, Gastropoda, Pterotracheoidea, Atlantidae): proposed conservation of the specific name. *Bulletin of Zoological Nomenclature*, **66** (3): 247-249.
- JANSSEN A.W. & SEAPY R.R., 2009b. On the identity and distribution of *Atlanta inflata* Gray, 1850 (Gastropoda, Pterotracheoidea, Atlantidae) in the world's oceans. *Basteria*, **73**: 139-157.
- JANSSEN A.W. & ZORN I., 1993. Revision of Middle Miocene holoplanktonic gastropods from Poland, published by the late Wilhelm Krach. In: JANSSEN A.W., JANSSEN R. (eds). Proceedings of the Symposium Molluscan Palaeontology, 11th International Malacological Congress, Siena, Italy, 30th August-5th September 1992. *Scripta Geologica, Special Issue* **2**: 155-236.



- KIRK T.W., 1880. Descriptions of new marine shells. *Transactions and Proceedings of the New Zealand Institute*, **12**: 806-807.
- KITTL E., 1886. Über die miozänen Pteropoden von Oesterreich-Ungarn, mit Berücksichtigung verwandter Vorkommnisse der Nachbarländer. *Annalen des Naturhistorischen Hofmuseums*, **1** (2): 47-74.
- KROHN A., 1860. Beiträge zur Entwicklungsgeschichte der Pteropoden und Heteropoden. Engelmann, Leipzig: 1-45.
- KUNZ A., 1996. *Schalenmorphologische Merkmale der Ontogenestadien ausgewählter Pteropoden (Gastropoda: Heterostrophia)*. Diplom-Arbeit Universität Hamburg (Geologie-Paläontologie): i-vi, 1-196 (unpublished).
- LALLI C.M. & CONOVER R.J., 1973. Reproduction and development of *Paedocione doliiformis*, and a comparison with *Clione limacina* (Opisthobranchia, Gymnosomata). *Marine Biology*, **19**: 13-22.
- LALLI C.M. & CONOVER R.J., 1976. Microstructure of the veliger shells of gymnosomatous pteropods (Gastropoda: Opisthobranchia). *The Veliger*, **18**: 237-240.
- LALLI C.M. & GILMER R.W., 1989. *Pelagic snails. The biology of holoplanktonic gastropod mollusks*. California, Stanford University Press, Stanford: i-viii, 1-259.
- AMANON [J.H.R. DE P. DE], 1797. *Mémoire sur les cornes d'ammon, et description d'une espèce trouvée entre les tropiques dans la mer du sud*. In: Milet-Mureau, M.L.A. (ed.). *Voyage de la Pérouse autour du monde*, **4**: 134-139, atlas pl. 63.
- LAURSEN D., 1953. The genus *Ianthina*, a monograph. *Dana Report*, **38**: 1-40.
- LESSON R.-P., 1830. Zoologie, 2 (1)(11). Mollusques, annélides et vers, 1. Mollusques. In: L.I. DUPERREY (ed.). *Voyage autour du monde, exécuté par ordre du roy, sur la corvette de sa majesté, La Coquille, pendant les années 1822, 1823, 1824 et 1825, sous le ministère et conformément aux instructions de S.E.M., le Marquis de Clermont-Tonnerre, ministre de la marine et publié sous les auspices de son excellence Mgr. le Cte de Chabrol, ministre de la marine et des colonies*. Bertrand, Paris: 239-448; atlas?
- LESUEUR [C. A.], 1813. Mémoire sur quelques espèces d'animaux mollusques et radiaires recueillis dans la Méditerranée, près de Nice. *Nouveau Bulletin des Sciences, par la Société Philomatique*, **3** (69): 281-285.
- LESUEUR C. A., 1817a. Characters of a new genus, and descriptions of three new species upon which it is formed; discovered in the Atlantic ocean, in the months of March and April, 1816; Lat. 22°9'. *Journal of the Academy of Natural Sciences*, **1**: 37-41.
- LESUEUR [C. A.], 1817b. Description de six nouvelles espèces de firoles observées par MM. Peron et Lesueur dans le mer Méditerranée en 1809, et établissement du nouveau genre Firoloïde. *Bulletin des Sciences, Société Philomatique de Paris*, (3)**4**: 157-160.
- LESUEUR [C. A.] 1817c. Mémoire sur deux nouveaux genres de mollusques, Atlante et Atlas. *Journal de Physique, de Chimie, et d'Histoire Naturelle*, **85**: 390-393.
- LEYEN A. VAN, SPOEL, S. VAN DER, 1982. A new taxonomic and zoogeographic interpretation of the *Diacria quadridentata* group (Mollusca, Pteropoda). *Bulletin Zoologisch Museum, Universiteit van Amsterdam*, **8**: 101-117.
- LINNAEUS C., 1758 (editio decima, reformata). *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*, 1. Salvii, Holmiae: 1-824.
- LINNÉ C. A., 1767 (editio duodecima reformata). *Systema naturae*, 1 (2). L. Salvii, Holmiae: 533-1327, register.
- LOCARD A., 1897. *Mollusques testacés*, 1. In: A. MILNE-EDWARDS (ed.). *Expédition scientifique du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883*, 1. Masson & Cie, Paris: i-vi, 1-516.
- MACANDREW R., 1870. Report on the testaceous Mollusca obtained during a dredging-excursion in the Gulf of Suez in the months of February and March 1869. *The Annals and Magazine of Natural History*, **6**: 429-450.
- MAGALDI N.H., 1977. Moluscos holoplanktonicos del Atlántico sudoccidental, 3. Heteropodos y pteropodos de aguas superficiales Braslenas y Uruguayas. *Comunicaciones de la Sociedad Malacológica del Uruguay*, **4** (33): 295-320.
- MEISENHEIMER J., 1905. Pteropoda. *Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer 'Valdivia' 1898-1899*, **9**: i-vi, 1-314.
- MEISENHEIMER J., 1906. Die Pteropoden der deutschen Südpolar-Expedition 1901-1903. *Deutsche Südpolar-Expedition*, **9** (Zool.) **1** (2): 92-153.
- MENZIES R.J., 1958. Shell-bearing pteropod gastropods from Mediterranean plankton (Cavoliniidae). *Pubblicazioni della Stazione Zoologica di Napoli*, **30**: 381-401.
- MONTEROSATO [T.A.] DI, 1875. Nuova rivista delle conchiglie mediterranee. *Atti della Accademia di Scienze, Lettere e Arti di Palermo*, (2a)**5** (Cl. Sc. Nat. esatto): 1-50.
- MONTEROSATO [T.A.] DI, 1878. Enumerazione e sinonimia delle conchiglie Mediterranee. *Giornale di Scienze Naturali e Economiche*, **13**: 61-115.
- MORLOTTI E. & TORELLI L., 1979. Planktonic foraminifera and pteropoda distribution in surface sediments of the Sardinia Basin. *Atti del Convegno Scientifico Nazionale del P. F. Oceanografia e Fondi Marini, Roma 5-7 marzo 1979*: 785-802.
- MORLOTTI E. & TORELLI L., 1980. Planktonic Foraminifera and Pteropoda distribution in surface sediments of the Sardinia Basin. *Volume dedicato a Sergio Venzo, Istituto Geologico, Parma*: 117-129.
- MÜLLER C., BLANC-VERNET L. & CHAMLEY M., 1975. Les coccolithophoridés d'une carotte méditerranéenne. Comparaison paléoclimatologique avec les foraminifères, les pteropodes et les argiles. *Tethys*, **6** (1974): 805-828.
- MUNTHE H., 1888. Pteropoder i Upsala Universitets Zoologiska Museum samlade af Kapten G. von Schéele. *Kungliga Svenska Vetenskapsakademiens Handlingar*, **14** (4) **2** (Bihang): 1-33.
- MUSEUM OF NEW ZEALAND, TEPAPA TONGAREWA, 2011. <http://collections.tepapa.govt.nz/objectdetails.aspx?oid=153267>
- NIEBUHR C., 1775. See FORSKÅL, P., 1775.
- NOFRONI I., 1984. *Cyclostrema solutum*, Di Geronimo 1974, larval shell of *Firoloida desmaresti* Leusueur [sic] 1817 (Heteropoda: Pterotracheidae). *La Conchiglia*, **16**: 23.
- NOFRONI I. & SILESU M., 1986. Rare molluscs from southern Sardinia. *La Conchiglia*, **18**: 6-7.
- NORDSIECK F., 1973. Molluschi abyssali dello Ionio. Abyssal molluscs from the Ionic-Sea. *La Conchiglia*, **5**: 4-7.
- OBERWIMMER A., 1898. Zoologische Ergebnisse, 10. Mollusken, 2 (Heteropoden und Pteropoden, *Sinusigera*) gesammelt von S.M. Schiff 'Pola' 1889-94. Berichte der Commission für Erforschung des östlichen Mittelmeeres, 21. *Denkschriften mathematisch-naturwissenschaftliche Klasse, Akademie der Wissenschaften, Wien*: 24 pp.
- ORBIGNY A. D', 1834-1847. *Voyage dans l'Amérique méridionale (le Brésil, la république orientale de l'Uruguay, la république Argentine, la Patagonie, la république du Chili, la république de Bolivie, la république du Pérou)*, exécuté pendant les années 1826, 1827, 1828, 1829, 1830, 1831, 1832 et 1833. Bertrand & Strasbourg, Levraut, Paris, 5: 1-48, 73-128, pls 1-2, 9-13, 15-16, 56, 1834; 49-72, 129-176, pls 3-8, 17-23, 25, 55, 1835; 177-184, pls 14, 24, 26-28, 30-32, 34-35, 37, 58, 1836; 185-376, pls 38-52, 57, 1837; pls. 54, 59-66, 68-69, 1839; 377-424, pls 53, 67, 70-71, 1840; 425-488, pls 72-76, 79-80, 1841; pls 83-85, 1842;



- 489-728, 1846; pls 78-79, 81-82, 1847 (xliii, 758 pp., 85 plates) (publication dates after Sherborn & Griffin (1934).
- PAFORT-VAN IERSEL T., 1985. *Contributions to pelagic zoogeography of the mid North Atlantic Ocean, 1. Distribution of pteropods, heteropods and silver hatchetfishes*. In: PAFORT-VAN IERSEL G.J.S. A contribution to pelagic zoogeography of the mid North Atlantic Ocean (7th paper). Amsterdam unpublished PhD, University of Amsterdam): 1-45 (with separate sheet of 'Statements').
- PASTOURET L., 1970. Étude sédimentologique et paléoclimatique de carottes prélevées en Méditerranée orientale. *Téthys*, **2** (1): 227-266.
- PELSENEER P., 1888. Report on the Pteropoda collected by H.M.S. Challenger during the years 1873-1876, 2. The Thecosomata. *Reports on the scientific Results of the Voyage of H.M.S. Challenger during the years 1873-1876*, **23** (1): 1-132.
- PELSENEER P., 1906. Biscayan plankton, 7. Mollusca (excluding Cephalopoda). With a note on their distribution by G. Herbert Fowler. *Transactions of the Linnean Society of London*, (**2**) **10** (zoology): 137-154.
- PÉRON [F.] & LESUEUR [C.A.], 1810. Histoire de la famille des mollusques ptéropodes; caractères de dix genres qui doivent la composer. *Annales du Muséum d'Histoire naturelle*, **15**: 57-68.
- PFEFFER G., 1880. Die Pteropoden des Hamburger Museums. *Abhandlungen des Naturwissenschaftlichen Vereins in Hamburg*, **7**: 67-99.
- PHILIPPI R.A., 1844. *Enumeratio molluscorum Siciliae cum viventium tum in tellure tertiaria fossilium, quae in itinere suo observavit*, 2. E. Anton, Halis Saxonum: i-iv, 1-303.
- PIANI P., 1980. Catalogo dei molluschi conchiferi viventi nel Mediterraneo. *Bollettino Malacologico*, **16**: 113-224.
- PIERROT-BULTS A.C., SPOEL S. VAN DER, 2003. Macrozooplankton diversity: how much do we really know? *Zoologische Verhandelingen Leiden*, **345**: 297-312.
- PILSBRY H.A., 1922. Revision of W.M. Gabb's Tertiary Mollusca of Santa Domingo. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **73**: 305-435.
- PRUVOT-FOL A., 1954. Mollusques opisthobranches. *Faune de France*, **58**: 1-460.
- QUOY [J.R.C.], GAIMARD [J.P.], 1827. Observations zoologiques faites à bord de l'Astrolabe, en mai 1826, dans le détroit de Gibraltar (suite et fin). Description des genres biphare, carinaire, hyale, flèche, cléodore, anafte et briarée. *Annales des Sciences Naturelles*, **10**: 225-239.
- QUOY [J.R.C.], GAIMARD [J.P.], 1832-1833. *Voyage de découvertes de l'Astrolabe, exécuté par ordre du roy, pendant les années 1826-1827-1828-1829, sous le commandement de M.J. Dumont d'Urville*. Zoologie, 2. J. Tastu, Paris: 1-686 (1832); atlas (with slightly differing title) mollusques pls 1-93, zoophytes pls 1-26 (without explanations) (1833).
- RAMAZZOTTI D. ET AL. (11 authors), 2006. Catalogo annotato e atlante iconografico dei molluschi marini del Mediterraneo, version 10.1.9.1. [http://www.naturamediterraneo.it/public/doram/NCIM\\_0.1.9.1.pdf](http://www.naturamediterraneo.it/public/doram/NCIM_0.1.9.1.pdf).
- RAMAZZOTTI D. ET AL. (12 authors), 2007. *Catalogo annotato e atlante iconografico dei molluschi marini del Mediterraneo*, version 0.1.9.9 Beta. [http://www.malachia.it/molluschi\\_marini\\_mediterranei.htm](http://www.malachia.it/molluschi_marini_mediterranei.htm).
- RAMPAL J., 1973. Clés de détermination des ptéropodes thécosomes de Méditerranée et de l'Atlantique euroafricain. *Revue des travaux de l'Institut des pêches maritimes*, **37**: 369-381.
- RAMPAL J., 1975. *Les thécosomes (mollusques pélagiques). Systématique et évolution - écologie et biogéographie méditerranéennes*. Thèse Université de Provence (Aix-Marseille 1): 1-485 (unpublished).
- RAMPAL J., 1979. Thécosomes tropicaux dans les sédiments de la mer Tyrrhénienne. *Rapports et Procès-verbaux des Reunions. Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée*, **25/26** (8): 149-150.
- RAMPAL J., 1996a. *Clio oblonga* n. sp. (Mollusque, Gastéropode, Euthécosome, Cavoliniidae, Clionae) fossile de thanatocoénoses quaternaires de la Méditerranée. *Géologie Méditerranéenne*, **23**: 175-185.
- RAMPAL J., 1996b. Une nouvelle espèce de *Corolla* (Gastéropode, Opisthobranchie, Pseudothécosome, Cymbuliidae). Remarques systématiques sur les genres *Cymbulia*, *Gleba* et *Corolla*. *Beaufortia*, **46**: 1-10.
- RAMPAL J., 2002. Biodiversité et biogéographie chez les Cavoliniidae (Mollusca, Gastropoda, Opisthobranchia, Euthecosomata). Régions faunistiques marines. *Zoosystema*, **24**: 209-258.
- RAMPAL J., 2011 (revision of the 1973 paper). Clés de détermination des Thecosomes (Pteropoda) (Mollusca Opisthobranchia holoplanctinique de Méditerranée et de l'Atlantique euroafricain. *Revue des travaux de l'Institut des pêches maritimes*, **37**: 369-391.
- RANG [P.C.A.L.], 1827. Observations sur le genre atlante. *Mémoires de la Société d'Histoire naturelle de Paris*, **3**: 372-381.
- RANG [P.C.A.L.], 1828. Notice sur quelques mollusques nouveaux appartenant au genre cléodore, et établissement et monographie du sous-genre créseis. *Annales des Sciences Naturelles*, **13**: 302-319.
- RANG S. [= P.C.A.L.], 1829. *Manuel de l'histoire naturelle des mollusques et de leurs coquilles, ayant pour base de classification celle de M. le Baron Cuvier*. Roret, Paris: i-vi, 1-390.
- RANG [P.C.A.L.], 1832. Atlante. *Atlanta*. Lesueur. In: *Magasin de Zoologie*, Seconde année: Classe V, Mollusques. Lequien fils, Paris: planche 4.
- RANG [P.C.A.L.], FÉRUSAC [D.] DE, 1830. Ueber die Pteropoden und andere Mollusken. *Notizen aus dem Gebiete der Natur- und Heilkunde*, **26** (17) (567): 260-262.
- RANG P.C.A.L., SOULEYET [L.F.A.], 1852. *Histoire naturelle des mollusques ptéropodes. Monographie comprenant la description de toutes les espèces*. Baillière, Paris: 1-86.
- RASMUSSEN L.B., 1968. Molluscan faunas and biostratigraphy of the marine younger Miocene formations in Denmark, 2. Paleontology. *Danmarks Geologiske Undersøgelse*, (**2**)**92**: 1-265.
- REUSS A.E., 1867. Die fossile Fauna der Steinsalzablagerung von Wieliczka in Galizien. *Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften, Wien*, **55** (1): 17-182.
- RICHTER G., 1968. Heteropoden und Heteropodenlarven im Oberflächenplankton des Golfes von Neapel. *Pubblicazioni della Stazione zoologica di Napoli*, **36**: 347-400.
- RICHTER G., 1972. Zur Kenntnis der Gattung *Atlanta* (Heteropoda: Atlantidae). *Archiv für Molluskenkunde*, **102**: 85-91.
- RICHTER G., 1974. Die Heteropoden der 'Meteor' Expedition in den Indischen Ozean 1964/65. 'Meteor' Forschungsergebnisse, (D)**17**: 55-78.
- RICHTER G., 1976. *Creseis chierchiai* Boas, eigene Art oder Jugendstadium von *Hyalocylis striata* (Rang)? *Archiv für Molluskenkunde*, **107**: 145-148.
- RICHTER G., 1979. Die thecosomen Pteropoden der 'Meteor'-Expedition in den Indischen Ozean 1964/65. 'Meteor' Forschungsergebnisse, (D)**29**: 1-29.
- RICHTER G., 1986. Zur Kenntnis der Gattung *Atlanta*, 2. *Atlanta lesueurii* Souleyet und *Atlanta oligogyra* Tesch (Prosobranchia: Heteropoda). *Archiv für Molluskenkunde*, **117**: 19-31.
- RICHTER G., 1987. Zur Kenntnis der Gattung *Atlanta*, 3. *Atlanta inflata*, *A. helicinoides*, *A. echinogyra* und *A. plana* (Prosobranchia: Heteropoda). *Archiv für Molluskenkunde*, **117**: 177-201.
- RICHTER G., 1993. Zur Kenntnis der Gattung *Atlanta*, 5. Die *Atlanta peroni*-Gruppe und *Atlanta gaudichaudi* (Prosobranchia: Heteropoda). *Archiv für Molluskenkunde*, **122**: 189-205.
- RICHTER G. & SEAPY R.R., 1999. Heteropoda. In: BOLTOVSKOY



- D. (ed.). *South Atlantic zooplankton*, 1. Backhuys, Leiden: 621-647.
- RIJCKEVORSEL R.H. VAN, 1988. *Een paleoecologische reconstructie van kern T87/2/20-section 3 aan de hand van Assemblage Zones van planktonische foraminiferen*. Internal Report, Afdeling Stratigrafie/Micropaleontologie, Instituut voor Aardwetenschappen, Rijksuniversiteit Utrecht: 1-45 (unpublished).
- ROLÁN E., GROH K., STRACK H.L., TEMPLADO J., VALDÉS A., 2005. *Malacological fauna from the Cape Verde Archipelago*, 1. *Polyplacophora and Gastropoda*. Conchbooks, Hackenheim: 455 pp.
- ROSENBERG G. 2009. *Malacolog 4.1.1: A Database of Western Atlantic Marine Mollusca*. [WWW database (version 4.1.1)]. <http://www.malacolog.org/>.
- SABELLI B., GIANNUZZI-SAVELLI R., BEDULLI D., 1990-1992. Catalogo annotato e atlante iconografico dei molluschi marini del Mediterraneo/Annotated check-list of Mediterranean marine mollusks, 1-3. Libreria Naturalistica Bolognese, Bologna: i-xiv, 1-348, 1990 (1); 349-498, 1992 (2); 499-781, 1992 (3).
- SARTORI R. 1977. *I campioni prelevati dal Laboratorio di Geologia Marina negli anni 1967-1974. Dati essenziali*. Consiglio Nazionale delle Ricerche, Laboratorio per la Geologia Marina, Bologna. Rapporto Tecnico: 685 pp.
- SEAPY R.R., 1990. The pelagic family Atlantidae (Gastropoda: Heteropoda) from Hawaiian waters: a faunistic survey. *Malacologia*, **32**: 107-130.
- SEAPY R.R., 2000. Species discrimination among pelagic heteropods: resolution of the *Pterotrachea hippocampus*-*P. minuta* problem. *Journal of Molluscan Studies*, **66**: 99-118.
- SEAPY R.R., 2008a. *Pterotracheidae Rafinesque, 1814*. <http://tolweb.org/Pterotracheidae/28734/2008.08.14> in The Tree of Life Web Project, <http://tolweb.org/>.
- SEAPY R.R., 2008b. *Protatlanta souleyeti* (Smith 1888). [http://tolweb.org/Protatlanta\\_souleyeti/28754/2008.10.29](http://tolweb.org/Protatlanta_souleyeti/28754/2008.10.29) in The Tree of Life Web Project, <http://tolweb.org/>.
- SEAPY R.R., 2010a. *Atlanta Lesueuri*, 1817. <http://tolweb.org/Atlanta/28752/2010.09.19> in Tree of Life Web Project, <http://tolweb.org/>.
- SEAPY R.R., 2010b. *Oxygyrus keraudreni* Benson 1835. [http://tolweb.org/Oxygyrus\\_keraudreni/28753/2010.04.01](http://tolweb.org/Oxygyrus_keraudreni/28753/2010.04.01) in Tree of Life Web Project, <http://tolweb.org/>. A new version of this page is found (2011) at [http://tolweb.org/Oxygyrus\\_inflatus/28753](http://tolweb.org/Oxygyrus_inflatus/28753).
- SEAPY R.R., 2011. *Atlanta*. <http://tolweb.org/tree?group=Atlanta&contgroup=Atlantidae> in Tree of Life Web Project, <http://tolweb.org/>.
- SEGUENZA G., 1867. Paleontologia malacologica dei terreni terziarii del distretto di Messina (Pteropodi e Eteropodi). *Memorie della Società Italiana di Scienze Naturali*, **2** (9): 1-22.
- SEGUENZA G., 1875. Studi stratigrafici sulla formazione pliocenica dell'Italia meridionale (continuazione). Elenco dei cirri e dei molluschi della zona superiore dell'antico Pliocene. *Bollettino del R. Comitato Geologico d'Italia*, **6** (3-4): 145-153.
- SEGUENZA G., 1876. Studi paleontologici sulla fauna malacologica dei sedimenti pliocenici depositatisi a grande profondità, 2. Quadro sinottico dei depositi laterali a submarini delle varie zone del Pliocene italiano. *Bollettino della Società Malacologica Italiana*, **2**: 18-49.
- SEGUENZA G., 1880. Le formazioni terziarie nella provincia di Reggio (Calabria). *Atti della reale Accademia dei Lincei*, (3), *Memorie della Classe di Scienze fisiche, matematiche e naturali*, **6**: 3-445.
- SHERBORN C.D. & GRIFFIN F.J., 1934. On the dates of publication of the natural history portions of Alcide d'Orbigny's 'Voyage Amérique Meridionale'. *Annals and Magazine of Natural History*, (10)**13**: 130-134.
- SHERBORN C.D. & WOODWARD B.B., 1901. Notes on the dates of publication of the natural history portions of some French voyages, 1. 'Amérique méridionale'; 'Indes orientales'; 'Pôle Sud' ('Astrolabe' and 'Zélée'); 'La Bonite'; 'La Coquille'; and 'L'Uranie et Physicienne'. *Annals and Magazine of Natural History*, (7)**7**: 388-392.
- SINGER B.S., 1994. An explosion of the pelagic population in the Gulf of Aqaba, January '94. *Levantina*, **80**: 8-10.
- SMITH E.A., 1888. Report on the Heteropoda collected by H.M.S. Challenger during the years 1873-1876. *Challenger Reports, Zoology*, **72** (23): 1-51.
- SOULEYET [L.F.A.]. In: EYDOUX [F.], SOULEYET [L.F.A.], 1852. *Voyage autour du monde exécuté pendant les années 1836 et 1837 sur la corvette 'La Bonite', commandée par M. Vaillant, capitaine de vaisseau, publié par ordre du Gouvernement sous les auspices du département de la marine*. Zoologie, 2. A. Bertrand, Paris: 1-664. See note above in Eydoux & Souleyet, 1841.
- SOWERBY G.B., 1878. Monograph of the genus Pteropoda. In: REEVE L.A. & SOWERBY G.B. *Conchologia iconica: or, illustrations of the shells of molluscos animals*, **20**. Reeve & Co., London: 14 pp., 6 pls.
- SPOEL S. VAN DER, 1967. *Euthecosomata, a group with remarkable developmental stages (Gastropoda, Pteropoda)* (thesis University of Amsterdam). J. Noorduijn, Gorinchem: 1-375.
- SPOEL S. VAN DER, 1969. Two new forms of *Cavolinia uncinata* (Rang, 1829) (Pteropoda, Gastropoda). *Beaufortia*, **16** (121): 185-198.
- SPOEL S. VAN DER, 1971. New forms of *Diacria quadridentata* (de Blainville, 1821), *Cavolinia longirostris* (de Blainville, 1821) and *Cavolinia uncinata* (Rang, 1829) from the Red Sea and the East Pacific Ocean (Mollusca, Pteropoda). *Beaufortia*, **19** (243): 1-20.
- SPOEL S. VAN DER, 1974. Geographical variation in *Cavolinia tridentata* (Mollusca, Pteropoda). *Bijdragen tot de Dierkunde*, **44** (1): 100-112.
- SPOEL S. VAN DER, 1975. Preliminary note on variation of protoconchae of *Clio pyramidata* (Linnaeus, 1767) (Mollusca, Pteropoda). *Bulletin Zoölogisch Museum Universiteit van Amsterdam*, **4** (21): 187-190.
- SPOEL S. VAN DER, 1976. *Pseudothechosomata, Gymnosomata and Heteropoda (Gastropoda)*. Bohn, Scheltema & Holkema, Utrecht: 1-484.
- SPOEL S. VAN DER, 1987. *Diacavolinia* nov. gen. separated from *Cavolinia* (Pteropoda, Gastropoda). *Bulletin Zoölogisch Museum, Universiteit van Amsterdam*, **11**: 77-79.
- SPOEL S. VAN DER, BLEEKER J., KOBAYASI H., 1993. From *Cavolinia longirostris* to twenty-four *Diacavolinia* taxa, with a phylogenetic discussion (Mollusca, Gastropoda). *Bijdragen tot de Dierkunde*, **62**: 127-166.
- SPOEL S. VAN DER, BOLTOVSKOY D. & JANKILEVICH S.S., 1981. Pteropoda. Clasificación y distribución. In: D. BOLTOVSKOY (ed.). *Atlas del zooplancton del Atlántico sudoccidental y métodos de trabajo con el zooplancton marino*. Mar del Plata, I.N.I.D.E.P.: 512-524.
- SPOEL S. VAN DER, NEWMAN L., 1990. Juveniles of the pteropod *Hyalocylis striata* (Gastropoda, Pteropoda). *Basteria*, **54**: 203-210.
- SPOEL S. VAN DER & PIERROT-BULTS A.C., 1979. Variation in *Cavolinia inflexa* (Lesueur, 1813) (Gastropoda: Pteropoda: Euthecosomata). *Zoölogische Verhandelingen*, **323**: 435-440.
- STEUER A., 1911. Adriatische Pteropoden. *Sitzungs-Berichte der Mathematisch-Naturwissenschaftlichen Klasse der k.k. Akademie der Wissenschaften in Wien*, **120** (1): 709-730.
- STRAATEN L.M.J.U. VAN, 1966. Micro-malacological investigation of cores from the southeastern Adriatic Sea. *Proceedings Koninklijke Nederlandse Akademie van Wetenschappen Amsterdam*, (B) **69**: 429-445.



- SWAINSON W., 1822. *Zoological illustrations, or original figures and descriptions of new, rare, or interesting animals, selected chiefly from the classes of ornithology, entomology, and conchology and arranged on the principles of Cuvier and other modern zoologists. Zoological Illustrations*, (1)2. Baldwin, Cradock, Joy & W. Wood, London: pls 84-119.
- SYKES E.R., 1905. On the Mollusca procured during the 'Porcupine' expeditions, 1869-1870. Supplemental notes, 2. *Proceedings of the Malacological Society London*, 6 (6): 322-332.
- TATE R., 1887. The pteropods of the older Tertiary of Australia. *Transactions and Proceedings of the Royal Society of South Australia*, 9: 194-196.
- TESCH J.J., 1903. Vorläufige Mitteilung über die Thecosomata und Gymnosomata der Siboga-Expedition. *Tijdschrift der Nederlandse Dierkundige Vereniging*, (2)8: 111-117.
- TESCH J.J., 1904. The Thecosomata and Gymnosomata of the Siboga Expedition. *Uitkomsten op Zoologisch, Botanisch, Oceanographisch en Geologisch Gebied, verzameld in Nederlandsch Oost-Indië 1899-1900 aan boord H.M. Siboga, onder commando van Luitenant ter zee 1e kl. G.F. Tydeman*, 52: 1-92.
- TESCH J.J., 1906. Die Heteropoden der Siboga expeditie. *Uitkomsten op Zoologisch, Botanisch, Oceanographisch en Geologisch Gebied, verzameld in Nederlandsch Oost-Indië 1899-1900 aan boord H.M. Siboga, onder commando van Luitenant ter zee 1e kl. G.F. Tydeman*, 27 (51): i-v, 1-112.
- TESCH J.J., 1908. Systematic monograph of the Atlantidae (Heteropoda) with enumeration of the species in the Leyden museum. *Notes from the Leiden Museum*, 30: 1-30.
- TESCH J.J., 1913. *Mollusca, Pteropoda*. In: F.E. SCHULZE (ed.). *Das Tierreich. Eine Zusammenstellung und Kennzeichnung der rezenten Tierformen*, 36. Friedberger & Sohn, Berlin: i-xvi, 1-154.
- TESCH J.J., 1946. The thecosomatous pteropods, 1. The Atlantic. *Dana Report*, 28: 1-82.
- TESCH J.J., 1947. Pteropoda Thecosomata. *Conseil International pour l' Exploration de la Mer, Zooplankton*, 8: 1-6.
- THIELE [K.H.] J., 1929-1935. *Handbuch der systematischen Weichtierkunde*, 1-2. Fischer, Jena: 1 (1): 1-376, 1929; 1 (2): 377-778, 1931; 2 (3): 779-1022; 2 (4): 1023-1154, i-vi, 1935.
- THIRIOT-QUIÉVREUX C., 1969. Caractéristiques morphologiques des véligères planctoniques des gastéropodes de la région de Banyuls-sur-Mers. *Vie et Milieu*, 20: 333-366.
- THIRIOT-QUIÉVREUX C., 1972. Microstructures de coquilles larvaires de prosobranches au microscope électronique à balayage. *Archives de Zoologie Expérimentale & Générale*, 113: 553-564.
- THIRIOT-QUIÉVREUX C., 1973. Heteropoda. *Oceanography and Marine Biology. An annual review*, 11: 237-261.
- THIRIOT-QUIÉVREUX C., 1975. Observations sur les larves et les adultes de Carinariidae (Mollusca: Heteropoda) de l'Océan Atlantique Nord. *Marine Biology*, 32: 379-388.
- TORELLI L. & BUCCHERI G., 1981. Late Quaternary stratigraphy of the Sardinia Basin sediments. In: WEZEL F.C. (ed.). *Sedimentary basins of Mediterranean margins Bologna. C.N.R. Italian project of Oceanography; Tecnoprint, Bologna*: 173-186.
- TORELLI L. & BUCCHERI G., 1983. Le associazioni a pteropodi del Pleistocene mediterraneo, 1. Analisi paleoclimatica della carota n. 1 del pozzo DSDP 125 (leg 13). *Geologica Romana*, 22: 157-175.
- TROSCHEL F.H., 1854. Beiträge zur Kenntniss der Pteropoden. *Archiv für Naturgeschichte*, 20 (1): 196-241.
- VATOVA A., 1974. Sui molluschi di alcuni saggi di fondo prelevati alle soglie del Mar Jonio. *Conchiglie*, 10: 93-112.
- VAYSSIÈRE A., 1915. Mollusques eutéropodes (ptéropodes thécosomes) provenant des campagnes des yachts Hiron-delle et Princesse-Alice (1885-1913). *Résultats des Campagnes Scientifiques accomplies sur son yacht par Albert Ier, prince souverain de Monaco*, 47: 1-226.
- VERA A. DE, & SEAPY R.R., 2006. *Atlanta selvagensis*, a new species of heteropod mollusc from the Northeastern Atlantic Ocean (Gastropoda: Carinariidea). *Vieraea*, 34: 45-54.
- VÉRANY [J.-B.], 1853. Catalogue des mollusques céphalopodes, ptéropodes, gastéropodes nudibranches etc.... des environs de Nice. *Journal de Conchyliologie*, 4: 375-392.
- VERGNEAU-GRAZZINI C., BORSETTI A.M., CATI F., COLANTONI P., ONOFRIO S. D', SALIÈGE J.F., SARTORI R., TAMPIERI R., 1988. Palaeoceanographic record of the last deglaciation in the Strait of Sicily. *Marine Micropaleontology*, 13: 1-21.
- VERGNAUD GRAZZINI C. & HERMAN ROSENBERG Y., 1969. Étude paléoclimatique d'une carotte de Méditerranée orientale. *Revue de Géographie Physique et de Géologie Dynamique*, (2) 11 (3): 279-292.
- VERRILL A.E., 1872. Brief contributions to Zoölogy, from the Museum of Yale College, 20. Recent additions to the molluscan fauna of New England and the adjacent waters, with notes on other species. *American Journal of Science*, (3) 3 (16): 281-290.
- VIOLANTI D., GRECCHI G. & CASTRADORI D., 1991. Paleoenvironmental interpretation of core BAN88-11GC (eastern Mediterranean, Pleistocene-Holocene) on the grounds of Foraminifera, Thecosomata and calcareous nannofossils. *Il Quaternario*, 4 (1a): 13-39.
- WATSON R.B., 1898. On the marine Mollusca of Madeira; with descriptions of thirtyfive new species, and an index-list of all the known sea-dwelling species of that island. *Journal of the linnean Society of London, Zoology*, 26: 233-329.
- WELLS F.E., 1974. *Styliola sinecostata*, a new species of pteropod (Opisthobranchia: Thecosomata) from Barbados, West Indies. *The Veliger*, 16 (3): 293-296.
- WELTER-SCHULTES F., 2011. Authorships of taxonomic names in malacology. *Mitteilungen der Deutschen Malakozoologischen Gesellschaft*, 85: 35-48.
- WELTJE G.J., 1988. *Paleo-ecologische en -oceanografische aspecten van planktonische foraminiferenfauna en sapropelvorming in het Laat Kwartair van de oostelijke Middellandse Zee*. Internal Report, Afdeling Stratigrafie/Micropaleontologie, Instituut voor Aardwetenschappen, Rijksuniversiteit Utrecht: 1-31 (unpublished).
- WENZ W., 1941. *Handbuch der Paläozoologie*, 6. Gastropoda, 1. Allgemeiner Teil und Prosobranchia, 5. Bornträger, Berlin: 961-1200.
- WIKIPEDIA, 2010. *Ligne (unité)*. [http://fr.wikipedia.org/wiki/Ligne\\_\(unit%C3%A9\)](http://fr.wikipedia.org/wiki/Ligne_(unit%C3%A9)).
- WILLAN, R.C., ALVAREZ, B., BURN R. & SPENCER, H.G., 2004. Comment on the proposal to emend the spelling of Clionidae d'Orbigny, 1851 (Porifera, Hadromerida) to Clionaidae to remove homonymy with Clionidae Rafinesque, 1815 (Mollusca). *Bulletins of Zoological Nomenclature*, 61: 167-169.
- WOODWARD S.P., 1890 (reprint of fourth edition, 1880). *A manual of the Mollusca, being a treatise on recent and fossil shells. With an appendix of recent and fossil conchological discoveries by Ralph Tate*. Crosby Lockwood, London: i-xiv, 1-542.
- WoRMS, 2011. *World Register of Marine Species*. <http://www.marinespecies.org/>.
- ZILCH A., 1959. *Gastropoda*, 2. *Euthyneura*, 1. In: WENZ W. *Handbuch der Paläozoologie*, 6: i-xii, 1-200.

All referred websites accessed June 2011.



appropriatamente disposte nello spazio disponibile, in modo da evitare ampie aree vuote. Lineette di scala, nere o bianche, possono essere applicate sulle illustrazioni. Le mappe vanno preparate come figure al tratto, semplici e prive di elementi grafici non utili ai fini del lavoro (es.: confini di stato), con le località citate nel testo ben evidenti. Le illustrazioni vanno tenute separate dal testo. La pubblicazione di illustrazioni a colori dovrebbe essere preliminarmente accordata con l'Editore. Gli originali delle illustrazioni vanno spediti solo dopo l'accettazione definitiva del manoscritto.

### TABELLE

Le tabelle vanno composte come files di testo, esattamente alla dimensione di stampa (si veda Illustrazioni), con un carattere *sans-serif* non più piccolo di 8-9 punti. Vanno evitati bordi spessi e griglie eccessivamente pesanti. Le tabelle sono citate nel testo come Tab. (es.: Tab. 2, Tabb. 3-6). Le abbreviazioni vanno spiegate in didascalia od in Materiale e metodi. Le tabelle non vanno inserite nel testo, ma salvati come files separati.

### EDITORIAL POLICY

The *Bollettino Malacologico* is published by the Italian Society of Malacology. Manuscripts on all aspects of malacology are accepted, in one of the following languages: Italian, English, French and Spanish. English is strongly recommended. Three issues per year are published. The publication of monographs and articles longer than thirty printed pages should be preliminarily arranged with the Editor. Manuscripts submitted for publication are considered on the understanding that their content is original, not already published or being submitted for publication elsewhere, and approved by all the co-authors. Manuscript submission should only be made electronically to the Editor-in-Chief (*r.laperna@geo.uniba.it*), as .doc or .rtf files. Illustrations should be sent as good quality .pdf or .jpg files. Authors are requested to apply the present instructions and the rules of the International Code of Zoological Nomenclature. Non fulfillment implies rejection of the manuscript by the Editor. Manuscripts are peer-reviewed by at least two reviewers. Potential reviewers can be suggested by the authors, but the final choice rests with the Editor.

### MANUSCRIPT ORGANIZATION

The first page contains title, author's name, author's mail and e-mail addresses. In case of joint-authored manuscripts, the corresponding author should be indicated. Title should be informative but as brief as possible, in lower-case, boldface. Avoid abbreviations. Names of high systematic rank are given in parentheses. The second page contains an abstract in the same language of the main text. For manuscripts in language other than English, a longer English summary is needed. Abstracts should report, in synthesis, the main results and conclusions of the work, not simply aims and generic statements. The distinctive characters of new taxa can be briefly reported, but not full descriptions or diagnoses. Avoid references to publications. A list of key words (not more than six) in the same language of the main text is also included in the second page. The main text should be organised in distinct parts, typically as follows: Introduction, Material and methods, Results, Discussion, Conclusions, Acknowledgements, References, in lower-case, boldface. In taxonomic works, Results are replaced with Systematics. Second level headings, such as Description, Material examined, Remarks, etc. are typed in lower-case, plain text. Avoid footnotes. Authors are requested to adopt a clear, concise style. Avoid long sentences. Offending or discriminatory words are forbidden. All the abbreviations and acronyms used in the text should be explained, preferentially under Material and methods. Use the standard abbreviations for measure units (e.g. "m", not "mt." for metre) and the official institutional acronyms. Italicize the names of genera, subgenera, species and subspecies but not those of higher taxa. When first mentioned, species and genus names should include authority and year of publication. Abbreviation of genus names is allowed but taking care to avoid confusion among different genera with the same initial. Italic should be also used for quotations in the original language (within quotation marks), if different from the manuscript language. The new taxa must be mentioned for the first time when they are described, except for the abstract. Latin can be optionally used for the taxonomic ranks (e.g. Familia or Family). Diagnoses (optional) and descriptions must be given in telegraphic style, whenever possible. Synonymies should include only the main references, useful to assess the species identity (e.g. based on material examined and well documented records).

*Example of systematic hierarchy and synonymy:*  
Family Cardiidae Lamarck, 1809  
Subfamily Cardiinae Lamarck, 1809

Genus *Acanthocardia* Gray, 1853  
(type species *Cardium aculeatum* Linné, 1758)

*Cardium indicum* Lamarck, 1819  
(Fig. 1A-D, Fig. 2C)

*Cardium hians* Brocchi, 1814: p. 508, pl. 13, fig. 6 (non Spengler, 1799).  
*Cardium indicum* Lamarck, 1819: p. 4.  
*Cardium (Cardium) indicum* Lamarck – Fischer-Piette, 1977: p. 112, pl. 10, fig. 4 (type).

### BIBLIOGRAPHIC CITATIONS AND REFERENCES

All the publications to which reference is made in the text, including synonymies (but not authors of homonyms), must appear in the final reference list, alphabetically ordered. Titles of journals and books in non-Latin alphabets should be transliterated, while paper

### DIDASCALIE

Le didascalie vengono riportate in una parte distinta del manoscritto, raggruppate ed in sequenza. Devono comprendere: nome ed autore della specie illustrata, origine del materiale, dimensioni reali (non l'ingrandimento!) e la collocazione (con numero di catalogo, se disponibile). Per i manoscritti in una lingua diversa dall'Inglese, è necessario aggiungere la traduzione in Inglese delle didascalie.

### BOZZE ED ESTRATTI

La pubblicazione sul *Bollettino Malacologico* è gratuita. All'Autore corrispondente verranno inviate le bozze, un'unica volta, per via e-mail. Sulle bozze verranno corretti gli errori tipografici e di altro tipo. Cambiamenti più importanti verranno addebitati all'Autore. Le bozze corrette vanno restituite all'Editore nel più breve tempo possibile. Gli Autori riceveranno gratuitamente una versione elettronica (pdf) dell'articolo. A richiesta, possono essere acquistati estratti secondo il listino fornito dal tipografo.

titles should be translated into English. A note indicating the original language, such as "[in Russian]" should be added. A careful cross-check between bibliographic citation in the text and reference list should be made before submitting the manuscript.

*Example of citations:*

... reported by Richardson & Smith (1965)

... as known in literature (Ross et al., 1993; Rosenberg, 1995, 1997; Michelini & Andriani, 2000)

... the original illustration (Torwald, 1879: p. 56, pl. 2, fig. 5).

*Example of references:*

SALAS C., 1996. Marine Bivalves from off the Southern Iberian Peninsula collected by the Balgim and Fauna 1 expeditions. *Haliotis*, **25**: 33-100.

GRILL B. & ZUSCHIN M., 2001. Modern shallow- to deep-water bivalve death assemblages in the Red Sea – ecology and biogeography. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **168**: 75-96.

BOSS K.J., 1982. Mollusca, in Parker S.P. (ed.), *Synopsis and Classification of Living Organisms*. Vol. 1. McGrow-Hill, New York: 945-1166.

CARTER J.G., CAMPBELL D.C. & CAMPBELL M.R. 2000. Cladistic perspectives on early bivalve evolution, in Harper E.M., Taylor J.D. & Crame J.A. (eds), The Evolutionary Biology of the Bivalvia. *Geological Society, London, Special Publications*, **177**: 47-95.

VOKES H.E., 1980. *Genera of the Bivalvia: a systematic and bibliographic catalogue (revised and update)*. Paleontological Research Institution, Ithaca, Edwards Brothers Inc., 307 pp

### ILLUSTRATIONS

Illustrations must be of high quality, in electronic format (.tiff), with a resolution not lower than 400 dpi for photographs and 600 dpi for drawings and graphics. They must be prepared exactly at the printing size, single column (8.4 cm) or double column (17.2 cm). The maximum printing size is 17.2 x 26.5 cm. The size of each illustration should be carefully and wisely chosen, based on complexity and quantity of images, for avoiding scientifically useless and aesthetically poor results, as well as waste of printing space. All illustrations are numbered as figures in a single series with Arabic numerals, in the same order as cited in the text. In composite illustrations, lettering of component images should be made with a *sans-serif* font, such as Helvetica or Arial, using capital letters 3-5 mm in height. Labels and abbreviations should be in lower-case letters. Illustrations should be referred to in the text as Fig. or Figs (not Figs.), whereas figures in another work are referred to as fig. or figs, as in the example: Fig. 3, Fig. 6A-F, Fig. 5A, 7B, Figs 3, 5. Images, mounted on black or white background, should be adequately sized, neither smaller than 4-5 cm, nor excessively large. They should be properly distributed in the available space, avoiding wide, empty spaces. White or black scale bars can be applied on illustrations. Maps should be given as line figures, as simple as possible, with the localities cited in the text clearly indicated. Illustrations are kept separate from the text. The publication of colour illustrations should be preliminarily arranged with the Editor. Originals should only be sent following final acceptance.

### TABLES

Tables should be composed as text files, exactly at printing size (see under Illustrations), using a *sans-serif* font not smaller than 8-9 pts. Avoid thick borders and heavy grids. They are referred to in the text as Tab. (e.g. Tab. 2, Tabs 3-6, not Tabs.). Abbreviations are explained in the captions or under Material and methods. Tables are kept as separate files, not embedded in the text.

### CAPTIONS

Captions are reported in a distinct section of the manuscript, grouped together in sequence. They must include: name and authority of the species, origin of the material, real size (not magnification!) and repository (with catalogue number if available). For manuscripts in language other than English, an English version of captions must be added.

### PROOFS AND REPRINTS

Publication on the *Bollettino Malacologico* is free of charge. One set of proofs will be sent to the corresponding author by e-mail, for the correction of inadvertent mistakes and printer's errors. More extensive alterations will be charged to the author. Corrections should be returned to the Editor as soon as possible. Contributors will receive an electronic version (pdf) on the article, free of charge. Reprints can be ordered according to the price list provided by the typographer.





Direttore responsabile: Paolo Crovato  
e-mail: [paolo.crovato@fastwebnet.it](mailto:paolo.crovato@fastwebnet.it)

Coordinamento produzione: Prismi srl, Napoli  
Grafica e impaginazione: Grafica Elettronica srl, Napoli  
Stampa: Arti Grafiche Solimene srl, Napoli  
Finito di stampare il 30 maggio 2012